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ENCYCLOPÆDIA BRITANNICA

SEVENTH EDITION.

THE

ENCYCLOPÆDIA BRITANNICA

OR

DICTIONARY

OF

ARTS, SCIENCES, AND GENERAL LITERATURE.

SEVENTH EDITION,

WITH PRELIMINARY DISSERTATIONS ON THE HISTORY OF THE SCIENCES,

AND

OTHER EXTENSIVE IMPROVEMENTS AND ADDITIONS;

INCLUDING THE LATE SUPPLEMENT.

A GENERAL INDEX,

AND NUMEROUS ENGRAVINGS.

VOLUME XVII.

ADAM AND CHARLES BLACK, EDINBURGH;

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ENCYCLOPÆDIA BRITANNICA.

Pantograph.

PANTOGRAPH, an instrument contrived for the purpose of copying drawings, so that the copy may either be of the same, of a greater, or of a less size, than the original. It consists of four moveable rulers fixed together by four pivots, and forming a parallelogram. At the extremity of one of these rulers prolonged is a point, which is drawn over the lines of the original drawing, whilst a pencil, fixed at the end of another branch of the instrument, traces on paper the lines of the copy. The pencil is placed in a hollow cylinder, and a weight is added on the top of the pencil; by this means the point of the pencil is made to press on the paper with the force requisite for drawing the lines. The improvements in the construction of different parts of the pantograph described in the *Mémoires de l'Acad. des Sciences*, 1743, have been generally adopted. The pantograph, however, is not found convenient in practice; and, for the purpose of copying maps, plans, and other designs, artists most commonly employ the method of dividing the original design into a number of squares, and the paper on which the copy is to be made into the same number of squares. When this is done, they copy the lines contained within each square of the original, so as to form a similar figure within the corresponding square of the reticula which covers the copy. When the drawing consists of straight lines, a reduced copy is accurately made by means of an isosceles triangle, in which the base is to the side as any line of the copy is to the corresponding line in the original. By setting off with the compasses any line of the original drawing on the sides of the triangle, the base which completes the triangle is the length of the corresponding line to be laid down on the copy. The same operation is performed by the sector.

If a drawing is to be copied, of the same size as the original, without diminution or enlargement, engravers usually trace the copy upon oiled paper laid over the original, or upon the transparent *papier de guimauve* (marsh-mallow paper), made in France.

A pantograph has been made, consisting of a rod, placed vertically, and turning round a fixed point in its length, situated between its upper and lower extremity; the upper end of the rod being a point which is conducted by the hand over the lines of the original drawing, and the lower end being the pencil which traces the copy on paper.

Pantograph.

An instrument upon this principle is sometimes used for drawing the profile of the face, in order to form small portraits or silhouettes.

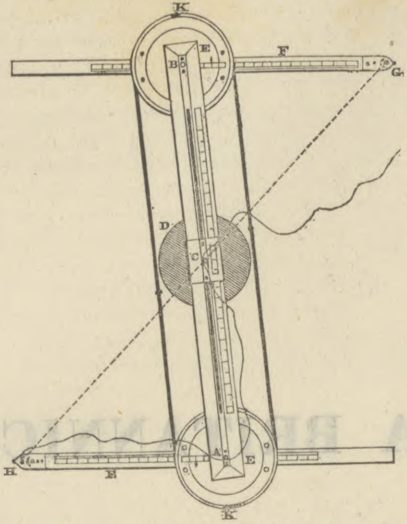
The instrument called micrograph and prosopograph in Puissant's *Géodésie* does not differ in principle from the common pantograph. (B. B.)

A very ingenious instrument for copying drawings, either upon a reduced or an enlarged scale, was invented by Mr Wallace, professor of mathematics in the University of Edinburgh. Of this instrument, which may be fitly introduced under the present head, though differing in *name*, we have been favoured with the following description.

It is a fact well known, that artists of various descriptions, who have frequent occasion to imitate original designs, have long felt the want of a convenient mathematical instrument, by which a copy may be made with neatness and expedition, that shall have any given proportion to the original. The *pantograph* is the only instrument that has hitherto been employed; but although correct and plausible in theory, in practice it is found to be so very imperfect that the artist hardly ever thinks of making use of it.

A consideration of the essential service that would be rendered to the graphic art, by a copying instrument, which should be at once simple in its theory and easy in its application, induced Mr Wallace to turn his attention to the subject; and, in the summer of 1821, he produced the model of a copying instrument, which he has denominated an Eidograph (from *εἶδος* and *γραφω*). The instrument, and its application to the copying of a great variety of subjects, has been shown to engineers, engravers, and other competent judges, in London and in Edinburgh; and their opinion of its utility has been such as to leave no doubt whatever of its completely fulfilling the views of the inventor.

The instrument is represented in the annexed figure.



The *beam*, AB, which is made of mahogany, slides backwards and forwards in a *socket*, C; and the socket turns on a vertical axis, supported by the *fulcrum*, D, which stands on a table. There is a slit in the beam, through which the axis of the socket passes, so that, when the beam slides in the socket, a portion of it passes on each side of the axis. There are two equal wheels, E, E, below the beam, which turn on axes that pass through pipes fixed at A, B, near its extremities; and a steel chain passes over the wheels as a band, by which a motion of rotation may be communicated from the one to the other. There are two *arms*, F, F, which slide in sockets along the lower face of the wheels, just under their centres; at the extremity, G, of one arm, there is a metal *tracer*, with a handle attached to it, by which its point may be carried over the lines in any design; and at H, the extremity of the other arm, there is a black-lead *pencil* fixed in a metal tube, which is ground to fit exactly into a pipe, so as just to slide up or down. In using the instrument, the pencil, in its tube, is raised by a thread which passes over a pulley, and it descends again by a weight with which it is loaded.

From the perfect equality of the wheels, it is easy to see that, if the arms attached to them be placed parallel in any one position, they will retain their parallelism, although one of the wheels, and consequently both, be turned on their centres. Supposing, now, that BC and AC, the parts into which the axis is divided at the centre, have any proportion whatever to each other, if the distances of the tracing point G, and pencil point H, from the centres of their wheels, have the very same proportion, then it follows, from the elements of geometry, that the tracing point G, the centre C, and the pencil point H, will be in a straight line; and further, that CG and CH, the distance of these points from the centre, will have to each other the constant proportion of CB to CA, or of EG to AH. Such being the geometrical property of the *eidograph*, if any subject to be copied be fixed to the table on which the instrument stands, and the tracing point be carried over every line of the design, the pencil point will trace a copy in all respects similar to the original. To facilitate the adjustment of the instrument, so that the copy may have any given ratio to the original, there are scales of equal parts on the beam and the two arms; by these and verniers, both halves of the beam, and equal lengths on the arms, are each divided into 1000 equal parts, and at certain intervals corresponding numbers are marked on them. By means of the scales, when any ratio is assigned, the adjustment is made without the least difficulty. To avoid any derangement by the chain slipping on the wheels, there are *clamps* at K and K, which hold it fast to the wheels at points where it never quits them. They are slackened when the instrument is adjusted.

PANTOMIME, Παντομιμος, amongst the ancients, a person who could imitate all kinds of actions and characters by signs and gestures, without speaking.

The pantomimes formed a part of the theatrical entertainments of the ancients; and their chief employment was to express by gestures and action whatever the chorus sung, changing their countenance and behaviour as the subject of the song varied. They were very ancient in Greece, being, according to some, derived from the heroic ages; but however this may be, they were certainly known in Plato's time. In Rome, it was as late as the reign of Augustus before they made their appearance. With respect to their dress, it was various, being always suited as near as possible to that of the person they were to imitate. The *crocota* was much used amongst the Roman pantomimes, in which, as well as in other female dresses, they personated women.

"The pantomimes," says Gibbon, "who maintained their reputation from the age of Augustus to the sixth century, expressed, without the use of words, the various fables of the gods and heroes of antiquity; and the perfection of their art, which sometimes disarmed the gravity of the philosopher, always excited the applause and wonder of the people. The vast and magnificent theatres of Rome were filled by 3000 female dancers, and by 3000 singers, with the masters of the respective chorusses. Such was the popular favour which they enjoyed, that in a time of scarcity, when all strangers were banished from the city, the merit of contributing to the public pleasures exempted them from a law which was strictly enforced against the professors of the liberal arts."

Pantomimes are still very common. In some respects indeed they differ from those of antiquity; but they retain the name, and, like these, they consist in the representation of things merely by gestures.

PANWELL, a town of Hindustan, in the province of Aurungabad, situated on the banks of the Pan, about seven miles from its mouth. It is an extensive place, and carries on a considerable trade. There are still here the remains of a brick fort built by the Mahratta chief Sevajee about the year 1680, to protect the inhabitants against the incursions of the Siddees. Panwell now belongs to the British. It is twenty-seven miles east of Bombay. Long. 73. 13. E. Lat. 19. N.

PANY ISLE, one of the Philippines, 110 miles in length by thirty-eight in average breadth. It is situated due south of Luzon, between the 122d and 123d degrees of east longitude. The island is marshy, and consequently unhealthy. When viewed from the sea, it exhibits numerous villages on the declivity of the hills, the houses of which are generally well built, and arranged with great regularity. In the interior are found deer, hogs, buffaloes, and wild animals; and cattle and horses range at pleasure through the uncultivated parts. The inhabitants manufacture handkerchiefs and cloths from cotton, and from the fibres of another plant, with which they supply the neighbouring islands. It has the reputation of containing gold and silver mines. The principal establishments of the Spaniards on this island are at Ilo-ilo and Antigua, on which coast there is good anchorage in ten fathoms, at a considerable distance from the shore. There is no security here either for life or property. The principal settlement, Antigua, is extremely ill governed and defended, vessels being plundered in the harbour by the pirates, who carry their crews into slavery. Long. 122. 33. E. Lat. 11. 15. N.

PAO, SAN JUAN DEL, a town of Columbia, in South America, about fifty leagues south-west from Caraccas. It is situated on the river Pao, the course of which was turned about the end of the seventeenth century, and, instead of flowing into Lake Valencia, directed into the Portugueza, a branch of the Apure, which itself is an affluent of the Orinoco. The town consists of several handsome streets, has a neat parish church, and is inhabited chiefly by the proprietors of the cattle reared on the fertile plains which surround the town. It contains a population of between 5000 and 6000. Lat. 9. 20. N.

PAO-KING, a city of China, of the first rank, in Houquang, situated on the river Lokyang, by which it communicates with the great lake Tongting.

PAOLA, a city of Italy, in the province of Calabria Citeriore, of the kingdom of Naples. It stands on the side of a hill, about one mile from the sea, and contains several churches and monasteries, 650 houses, and 4500 inhabitants, who are chiefly employed in making wine and oil, and in the manufacture of earthenware.

PAOOM, one of the smaller of the New Hebrides, in the South Pacific Ocean, and which appeared to Captain Cook to be two islands. Long. 168. 20. W. Lat. 16. 30. S.

PAOTING, a city of China, of the first rank, in the province of Pe-che-lee. It is the residence of the viceroy, and ranks next to Pekin amongst the cities of the province. It is seventy-seven miles south-south-west of Pekin. Long. 115. 14. E. Lat. 38. 54. N.

PAPA, a town of the Austrian kingdom of Hungary, in the province of the Hither Danube, and the circle of Weszprimer. It contains a palace of Esterhazy, a Catholic, a Lutheran and a Reformed church, with a seminary belonging to the last of these religious sects. There are 780 houses, with 5150 inhabitants, who grow some excellent wine. Long. 17. 20. 55. E. Lat. 47. 19. 32. N.

PAPAL STATES. Under the article ITALY we have traced the origin and growth of the temporal power of the Roman pontiffs. In the article ROME we shall exhibit a view of the rise and progress of that great state which, first as a republic, and subsequently as an empire, obtained the command of the western world The present article will be limited to a view of the temporal dominions of the sovereign pontiff, in the state in which they actually exist.

This territory is situated in the centre of Italy, being bounded by the Adriatic Sea on the eastern, and the Mediterranean on the western side. It extends in north latitude from 41. 9. 8. to 44. 49. 54., and in east longitude from 10. 26. 2. to 12. 49. 30. The whole is connected together, with the exception only of two small portions. One of these is the dukedom of Benevento, which is surrounded by the Neapolitan province of Principato Ulteriore; and the other the principality of Pontecorvo, enclosed within the province of Terra di Lavoro, belonging to the same state. The papal dominions are bounded on the north-western side by the Austrian kingdom of Venetian Lombardy, on the north-eastern by the Adriatic Sea, on the south-eastern by the kingdom of Naples, on the south-western by the Mediterranean Sea, and on the west by part of the grand duchy of Tuscany and a portion of the duchy of Modena. As the two seas, which form partly the eastern and western boundaries of the papal dominions, afford supplies of food, and might be made the means of considerable foreign trade to a more active and enterprising people, they deserve to be noticed. A short description of the shores, the harbours, and the bays, may also be of interest.

The western coast of the pope's dominions is by far the shortest. It commences a little to the south-east of Orbitello, in the Tuscan territory, and proceeds by a bay, not deep, to Civita Vecchia. It has no towns on the shore; but about three miles inland, and visible from the sea, are the cities of Montalto and Corneto, neither of which has any foreign trade. Civita Vecchia is the principal seaport on this side. It is well fortified with good walls and ditches, several half-moon batteries, and various other works; and upon a peninsula is a fine castle, from which a mole is projected, whilst another mole about 180 fathoms in length is carried into the sea. Between these two is the harbour, having seventeen feet of water at one of the entrances, and twelve feet at the other. Ships are safe everywhere within the harbour, and have twenty feet of water. Proceeding to the south-east of this port, the church of St Peter's at Rome is visible nearly the whole of the course, but more distinctly after passing the Cape Linaro. There are only a few miserable villages upon the shore; but the small towns of Marinella, Palo, and Montcrone, about two miles from the sea, are visible. The river Tiber has two outlets to the sea, which are divided by the Isola Sacra, a tract of land about half a league in breadth. Of these, the first or northernmost is called the Bocca del Fiumecino, and the second Bocca de Fiumara. All the land near and about the mouths of the Tiber is low and marshy, and not easily distinguishable from the water; which renders the approach dangerous, especially when, as is often the case, it is covered with dense fogs. The only mouth of the Tiber for vessels is the Bocca del Fiumecino. It has a bar at its mouth, with seven or eight feet of water, and within it from two to four fathoms. The Bocca de Fiumara has only two feet of water on its bar, and consequently can be entered by nothing larger than boats. There is good anchorage at the distance of from three to six miles from the shore, where there is a depth of water of from six to thirteen fathoms, with good holding ground of stiff mud.

From the mouths of the Tiber the land continues low and marshy, and it has no town, but a few houses and towers at intervals; and, like the rest of the Campagna di Roma, of which it forms a part, is frequently so obscured by haze and fog, that the objects on the shore are not easily distinguishable. At the distance of about thirty miles from the Tiber, near a projecting headland called Cape d'Anzo, is the port and mole of Nettuno or Neptune. The mole projects 200 fathoms into the sea, and, by means of a bend towards the termination, forms a harbour, in which there is a secure anchorage, with a depth of water of from fifteen to twenty feet. The town is small, but ancient. About two miles from the mole, on the sea-shore, and around it, are several vaults, grottos, baths, and pillars, hewn out of the rocks, with other monuments of ancient magnificence. At twenty miles from Nettuno is Cape Circeo or Circello, which forms a deep bay, with a low marshy coast, near to which good anchorage, in six or seven fathoms water, is found; but there is no shelter against winds from the south-east. At ten miles from thence is Terracina, the last town of the ecclesiastical territory on the Neapolitan frontier. It was Anxur, the capital of the Volsci, in ancient times. The harbour, once of celebrity, is now choked up; and the town, though fortified, is inconsiderable. The country around is fruitful, but marshy and unwholesome.

The eastern sea-coast of the Papal States, bordering on the Adriatic Sea, extends about 120 miles in length. It commences to the south at the river Tronto (the ancient Truentus), by which it is divided from the territory of Naples, and extends to the southern mouth of the river Po, where the Austrian state of Lombardy commences. From the Tronto towards the north there are along the shore a number of small towns and villages, defended by towers, but no harbour or place of shelter, and the coast generally is low and sandy. The names of the principal places are Termoli, Vasto, Ortona, Francavilla, Pescara, and Giulianova. Next to these is the town of Fortore, where there is a great storehouse, in the form of a tower, which may be seen a long way off. To this storehouse merchandise is sent from the inland towns to be shipped; and there is good anchorage near it, with a depth of water of from six to seven fathoms, on sandy ground. About forty-five miles from the Tronto, the land trending north by west half west, is Monte Conero, or the Mountain of Ancona; but this whole line of coast is low. At seven miles north-west by north from the foot of the mountain is the mole of the city of Ancona, a surprising work, by which the harbour is formed. This mole is 2000 feet in length, 100 feet in breadth, and sixty-eight feet in height. On its point there are a battery and a lighthouse, and near it a triumphal arch of white marble, erected in honour of the Emperor Trajan, and considered as one of the most perfect remains of Roman magnificence now existing. The port has a lazaretto, where the quarantine regulations are very strict. The city is defended by a strong fort, in a low situation, on the south side. Ancona is a free port, and vessels may lie in its harbour secure from all winds, as the mole towards its termination has a turn to the west, forming a hook; it is, however, too full of shoals ever to be of consequence as a naval port. Three or four frigates may be well sheltered within the lighthouse, moored by the head and the stern; but in no part of the harbour could ships of that class swing to their anchors. The city is walled, and contains about 20,000 inhabitants. It has the best arsenal in the Roman dominions. The trade is considerable, arising chiefly from the exportation of corn, wool, and silk. The most appropriate merchant-ships for Ancona are those not drawing more than sixteen feet of water.

From Ancona to Rimini, a distance of about fifty miles, the coast is of moderate height, and the shore is of sand. The chief towns are Sinigaglia, Fano, Pesaro, and Rimini; but at none of these is there a harbour for shipping. Sinigaglia has only a mole to protect small craft; but a great fair is held here, to which many of the Greeks resort, and exchange honey, wax, tar, and other articles, for hemp, wheat, and silk. It is said to contain 10,000 inhabitants. Fano and Pesaro possess little or no trade, but are ancient places, each furnished with a great number of churches. Rimini is a small, decayed, but still elegant place, situated on the south point of the river Marecchia, near the mouth of which there is good anchorage, on muddy ground, in seven fathoms water; but there is no shelter from the sea-winds. Under the French government, Rimini was the capital of the department of the Rubicon, and contained 16,000 inhabitants. At four leagues farther to the north there is good anchorage opposite the town of Cesenatico, a place inhabited for the most part by fishermen. It is connected by a canal with the modern town of Cervia, around which there is an extensive plain, used in summer for the production of salt by natural evaporation. Upon the river Montone, about five miles distant from the sea, stands the city of Ravenna, once an important place, and the seat of government, but now fallen into decay, though still containing 16,000 inhabitants, and possessing several silk manufactories, and a considerable commerce. The river Montone is navigable for small vessels only, and its entrance is denoted by a beacon or moat, on which a light is hoisted at night. At the tower of Volano is the little port of Goro, the westernmost branch of the river Po, within which ships may enter and be secure in six fathoms water; and at four leagues from that point the Roman territory is terminated at Punta della Maestro, the outer point of the main stream of the Po. The alluvial matter of the different branches of that powerful stream has formed numerous shoals, which extend to a considerable distance from the shore, and the bank extends outwards to the distance of two leagues. Within the shoals vessels may haul up, and do so occasionally, in from six to ten fathoms water. The mouths of the Po present a figure much resembling those formed by the Mississippi in America. The river, from its source in the Alps, has a course of nearly 280 miles to the sea, and is augmented by many smaller rivers which fall into it, most of its branches being navigable by small vessels. The current is very strong, and great injury has often been done by inundations. To prevent this, strong dikes have been gradually raised on its banks, and its bed has in consequence become so elevated that the level of its waters, especially in the lower part of its course, are several feet above that of the neighbouring lands.

On the whole of the eastern coast, which has been here surveyed, there are a great number of small streams running to the sea. They have their source in the range of the Apennines, at no great distance, and are consequently of short but rapid course. Many of them are dry or nearly so in the summer, at which season the whole district suffers very severely from the want of fresh water.

The present division of the States of the Church is as follows:—

Provinces.	Extent in English Square Miles.	Population.	Cities.	Towns.	Villages.
Comarca di Roma	880	272,529	6	5	200
Legations, viz.					
Bologna	1675	306,675	2	21	371
Ferrara	1100	205,084	2	13	254
Ravenna	924	148,989	4	8	138
Forli	1232	188,097	6	9	332
Delegations, viz.					
Urbino, with Pesaro	1100	216,071	12	16	410
Ancona	550	155,397	3	17	410
Macerata, with Camerino	1474	143,820	9	17	404
Fermo, with Ascoli	1056	160,936	4	15	82
Perugia	1782	188,598	7	19	316
Spoleto	1828	148,598	6	14	204
Viterbo, with Civita Vecchia	1892	145,022	13	24	276
Frosinone	1364	117,537	7	5	200
Benevento	88	22,704	1	0	8
Velletri	660	51,500	6	7	124
	17,605	2,471,557	88	190	3729

The Marquis Vanni, who was empowered by the government in 1834 to make an enumeration, returned the population as somewhat greater, namely, as 2,592,329; and these were classed in the following manner:

Agricultural proprietors	1,176,178
Manufacturers, handicrafts, and labourers	691,805
Persons of liberal professions	24,908
Military and marine persons	21,508
Priests, monks, and nuns	53,484
Children below working age	624,446
	2,592,329

The cities containing more than 10,000 persons, with the population of each respectively, are the following:—

Rome (in 1836)	152,457	persons.
Bologna (in 1832)	69,000	...
Perugia	30,000	...
Ancona	24,000	...
Ravenna	24,000	...
Ferrara	24,000	...
Fermo	19,000	...
Faenza	18,500	...
Rimini	17,000	...
Forli	16,000	...
Macerata	15,600	...
Foligno	15,400	...
Cesana	15,000	...
Fano	15,000	...
Benevento	14,000	...
Pesaro	13,900	...
Viterbo	13,000	...
Osimo	12,300	...
Urbino	12,000	...

The population of all these cities, including that of Rome itself, does not exceed one fifth of the whole number of inhabitants. Many of the inhabitants of those cities are more or less dependent upon agriculture, and those of the smaller cities and towns are chiefly so. It may in this way be estimated, that the labour of three fourths of the inhabitants on the soil is required to produce a sufficiency of food for the whole number of consumers. The density of the population may be taken as one human being to four acres and a half of land.

According to the Marquis Vanni, the land is appropriated in the following manner:

Under the plough	242,000 rubbie.
Vineyards	14,600
Feeding land	162,000
Garden culture	1,400
Woods and forests	170,000
	590,000

The rubbia is a measure of land nearly equal to four English statute acres.

The face of the Roman territory, with the exception of those parts on the north which form part of the valley of Po, and the portion to the south on the banks of the Tiber, is hilly, and much of it mountainous. The chain of the Apennines, after forming the boundary between the Bolognese and Tuscany, enters the States of the Church near St Sepulchro, and runs through them, in the direction of north-west and south-east, at nearly an equal distance from the Mediterranean and Adriatic Seas; and then is continued through the Neapolitan provinces of the Abbruzzi, embracing in their course the valley in which the city of Rome stands. From this range of mountains spurs project on both sides, some of them extending to the Mediterranean Sea, and others to the Adriatic; and between these projections are to be found valleys of much beauty, and of the highest degree of fertility. Without any visible communication with this ridge of mountains stand the lofty elevations of the Sorriano and Fogliano in Viterbo, and the St Oreste and Monte Cavo in Frosinone. The mountains here are as naked and as desolate as those in Tuscany and in the vicinity of Genoa, but much more lofty. The highest of the Velino, to the north-west of Rome, rises 7870 feet above the level of the sea; Monte della Sibylla, on the border of the Abbruzzi, is 7058 feet; and the Somma is 6800 feet. The promontories are much lower. That of Gennaro, near Rome, is only 3924 feet, Monte Cavo 2923, and Monte Rocca di Papa only 2230 feet in height.

The summit of these mountains is composed of granite, in which are found imbedded portions of talc, gneiss, and schist. The offshoots consist in some parts of calcareous stone, and in others of volcanic tuffa, basalt, and lava. The promontories appear to be for the most part of volcanic origin, the product of that matter which seems to extend under the south of Italy. The great northern plain, which is bounded by the Apennines, the river Po, and the Adriatic Sea, has the same character as the plains of Austrian Lombardy. It is covered with a rich marshy soil, which, near Commachio, terminates in an almost useless and always insalubrious swamp. Along the south-western coast extend vast swamps, which are occasionally flooded by the sea. They are scarcely habitable, though sometimes shepherds resort to them. The pestilential volcanic air, impregnated with sulphur, causes them to be avoided. These districts, from the mouth of the river Astura to Terracina, contain the Pontine Marshes, which neither the emperors of ancient nor the popes of modern Rome have been able to render of any value. What Pope Pius VI. performed has been of no avail; and these pestiferous swamps seem to be constantly extending.

The Mediterranean Sea receives the water of but one considerable river in the Papal States. The celebrated Tiber rises in the Apennines, near St Albonigo, in the duchy of Tuscany, enters the Roman territory at the town of Sepulchro, and, taking a south-westerly direction, after a course of nearly 150 miles, and passing through Rome, falls into the sea at Ostia. It is only navigable for the last fifteen miles between the metropolis and its mouth. The tributary streams of the Tiber are the Topia and the Chiana, which originate in Tuscany, and a few small brooks and rivulets. The principal river of the Roman States is that which forms one of its boundaries, the Po. From the Roman States its water is augmented by the streams of the Panaro, the Reno, the Riolo, the Porotto, the Idice, the Santerno, the Senio, and the Lamone. These various streams are, for the most part, united by canals, and rendered navigable; and they also greatly contribute to cultivation, by affording easy means of irrigating the fields near them. Besides the Po, the other streams which empty themselves into the Adriatic from the papal territory are the following: The Montone, which runs into the sea near Ravenna; the Savio, which empties itself near Forli; the Uso, a small stream near Forli, which has become celebrated from the pope having decided, in 1756, that it was the Rubicon, though the inhabitants still maintain that the Piscatella, a small river near it, is that at which Julius Cæsar hesitated; the Matauro, which runs by Fano; the Cessano, near Urbino; the Musone, the Leta, the Asone, and the Tronto, which last forms the boundary between the Roman States and the territory of Naples.

There are several lakes in the Papal States. The largest of these is that of Perugia and Trasimeno, celebrated for the victory obtained there by Hannibal over the Romans. On the latter there are three islands. It is well stored with fish, and the outlet is into the Tiber. The lake of Bolsena is a little to the north-west of Viterbo, and was known in ancient times by the name Vulsinius. It has two islands. There is another lake near to it, that of Bracciano, which was formerly called Sabatinus. Besides these three lakes, there are many smaller, such as the charming Lago d'Albano and Lago di Remi, in the vicinity of Rome; Lago Pie di Luca, in Rieti; the lakes of Fogliana, of Monaco, of Crapolace, and Caressa, in the Pontine Marshes; and those of the valley of Commachio.

The mountainous parts of this territory abound in mineral springs of various degrees of medicinal celebrity. Those most frequented are the acid springs near Rome, the baths of Bracciano, the baths of Stigliano near Tolfa, the baths of Palazzi near Civita Vecchia, the warm baths and acid springs of Viterbo, the baths of Giosinelli near Montefiascone, the baths of Porretta in Bologna, and the Lago di Bagni, of tepid water, from which alum and sulphur are obtained, and which is much used for immersion.

The climate of the Ecclesiatical States varies much, according to the local position of the several parts. Some of those produce the orange in perfection, whilst others are covered with snow during great part of the year. The tops of the Apennines are clothed with snow in October, and it generally remains till May. The northern part, in the valley of the Po, has the climate of Lombardy, and the environs of Rome that of Sicily; whilst at Terracina the heat of the Antilles is felt, without the refreshing trade-winds. There the dates ripen, and the gardens are enclosed with fences formed by the aloe. The heat is but slightly tempered by breezes from the sea; and these parts are subject to the visitation of the dreaded sirocco. The air upon and between the Apennines is generally favourable to health; but on the Pontine Marshes, and near the mouths of the Po, as well as near to Rimini, the marshes are gradually extending, and their pestiferous influence is observable in the increase of dense fogs, and the rapid diminution of the population.

The description of the agriculture of Lombardy, given under that head in the present work, will apply to the portion of the territory of the Church near the Po, in the four delegations of Bologna, Ferrara, Ravenna, and Forli. In the other parts the art is most negligently exercised, as well in the Apennines as in the plains of Rome itself. The Roman States produce a sufficiency of corn for their own consumption; for if some districts are deficient, the others are more than sufficient. Wheat, maize, and barley, are the chief grain; but the great mass of the poorer people eat but little bread, and, especially in the Apennines, substitute chestnuts, onions, garlic, and beans instead of it. A great part of their food consists of fruits, culinary vegetables, and salads. They rarely taste animal food, except a little bacon or sausages. Flax and hemp are raised in sufficient quantities to supply the inhabitants; and saffron is produced to such an extent that it has become an article of export. Some cotton is raised, and the growth of it is rapidly extending. In some parts many plants are raised that are applied by the perfumers to their preparations, such as spikenard, annis, and others. The olive grows everywhere, but is almost exclusively destined to domestic consumption.

Wine is generally cultivated, but the management of the vines is careless, and the selection of the kinds of them very negligent and injudicious. The best wine is made about Montefiascone, Orvieto, and Monte Cavo; but the greater part of the common wine is very indifferent. Some little of a moderate quality is made about Bologna and Ravenna, part of which finds a market in Venice. The land produces a great variety of fruits. In the plain of Rome, oranges, citrons, pomegranates, and figs ripen; and amongst the Apennines there is an abundance of almonds, pistachio-nuts, and walnuts, and especially of chestnuts. The forests produce wood for fuel, and some little is sent to the Isle of Elba to supply the iron-works. On several parts of the coast much soda is prepared. The woods of Terracina have many cork-trees, the bark of which becomes an article of foreign commerce.

Formerly the breeding of horses was carefully attended to, but of late it has been negligently pursued; and the celebrated race known by the name of Borghese has deteriorated, and nearly disappeared. On the Apennines asses and mules are used as beasts of burden, for riding, and for the plough. Oxen are almost universally employed. The breed of cows is very fine; and they roam about the Campagna di Roma almost without attendance. The milk is not converted into cheese or butter, but the profit they yield to the proprietors, some of whom have herds of nearly two thousand, arises from the sale of the calves, and of the mothers when fattened. Sheep are very numerous, especially on the shores of the Mediterranean. There are two distinct races. One of these, called *negretti*, are small, with very strong and very white wool, as fine as that of Aragon, whence the race, as well as the name they bear, has been derived. They give abundance of milk, from which much cheese is made. These flocks, like their ancestors in Spain, are migratory. In the month of May they march from the plains near Rome to the mountains of Norcia and Abbruzzi, and return again in October. The other race of sheep, called *pouille*, are inferior in their wool, and are stationary on the Apennines, and the lands situated on the Adriatic shore. Goats are very numerous, both on the plains and on the Apennines. They yield abundance of milk, which is converted into cheese; but much of it serves to sustain the swine, of which large herds are bred and fattened upon some of the most extensive farms. The culture of silk is one of the most important objects in Roman agriculture, and gives occupation to almost every member of certain families for the season. The soil is favourable to the growth of the white mulberry, the leaves of which yield the finest silk; that of the best quality, collected near Fossombrone, is chiefly exported to England and Germany.

The manufacturing operations of the Ecclesiastical States are very confined, and chiefly adapted to domestic consumption. The chief seat of the silk manufactory is Bologna, which formerly had the monopoly of the trade in crapes, but now divides it with the fabrics of other parts of Europe. Linen and woollen cloths are made, some good paper is produced, and leather is made in several parts; also glass, pottery, rosaries from Loretto, artificial flowers, tallow, and wax-candles, with a variety of small articles.

There are no mines worked within the Roman territory, but considerable quantities of excellent alum and of sulphur are furnished, and some saltpetre; and on the coast there are lagunes, from which culinary salt is made by the natural evaporation of the sun's rays.

The subjects of the Roman pontiff all adhere to the Catholic church, with the exception of 16,000 Jews. The states have six archbishops, seventy-two bishops, 1824 religious houses for monks, and 612 nunneries, and 2098 parochial divisions. The civil government is in the hands of the college of cardinals, and the executive is administered by the Cardinal Vicarius, who is a kind of prime minister. The universities in actual operation are but three, viz. Bologna, with 680 students; Rome, with 460; and Perugia, with 200. Besides these, four others have been decreed in Camerino, Fermo, Macerata, and Ferrara, but are not as yet established. In most of the cities there are schools of the fine arts, which tend to keep alive the attachment to music, painting, statuary, and antiquities, for which, with architecture, Italy has long been celebrated. The education of the poorer classes is less attended to than in some other parts of Europe.

The military force of the Holy See, as regulated by a decree of the 29th of December 1834, consists of ten battalions of native and two of foreign infantry, one regiment of dragoons, one of carabineers, two of sharp-shooters or riflemen, and a corps of artillery, the whole amounting to 17,372 men, and 1524 horses. There is at present no marine force of any description.

The finances of the Roman States are not clearly known.

The public debt is calculated to exceed eight millions sterling, and to be annually increasing, although the taxes levied are said to be heavier in proportion to the wealth of the community than they are in any of the other European states. (G.)

PAP CASTLE, in England, in Bridekirk parish, Cumberland, originally stood two miles from Cockermouth, on the other side of the Derwent. Its antiquity is proved by several monuments; and a large green stone vessel found here, with little images upon it, is supposed to have been formerly a Danish font. Pap Castle, which seems to have been so called from Pipard, its owner, is said to have been demolished, and the materials employed in building Cockermouth Castle.

PAPEMBERG, a high island off the coast of Japan, called by the natives Takaboko, or Takajama.

PAPER.

PAPER is a word derived from the Greek πάπυρος, *papyrus*, the name applied to the celebrated Egyptian plant which was so much used by the ancients in all kinds of writing. It is unnecessary to describe the different expedients which men have in every age and country employed for giving permanence to their ideas, and handing them down to posterity. When the art of writing was once discovered, stones, bricks, leaves of trees, the outer and inner bark, plates of lead, wood, wax, and ivory, were all employed. In the progress of society, men have invented the Egyptian paper, paper made of cotton, paper manufactured from the bark of trees, and in our times paper prepared from old rags.

The only kinds of paper which merit particular attention are, first, the Egyptian; secondly, that made from cotton; thirdly, paper made from the interior bark of trees; fourthly, Chinese paper; fifthly, Japanese paper; sixthly, paper made from asbestos; and, lastly, paper prepared from linen and cotton rags.

Egyptian paper.

Egyptian paper is that particular kind which was used by the ancients, having been made from a kind of reed called *papyrus*, which grew on the banks of the Nile. Isidorus is of opinion that this paper was first used at Memphis, and Lucan (*Pharsalia*, lib. iii. ver. 222), speaking of a particular period, says,

> Nondum flamineas Memphis connexere biblos
> Noverat.

But however this may be, it is certain, that of all the kinds of paper used by the ancients, the papyrus was the most convenient, both from its flexibility, and from the ease with which it was fabricated. In fact it seemed a present from nature, and required neither care nor culture. It is not certain at what particular period the ancients began to make paper of papyrus; but there are several authorities which prove that it was prepared in Egypt long before the time of Alexander the Great.

Pliny (lib. xiii. cap. 11) gives a very full description of the method of making this paper in Egypt. According to him, they divided, with a kind of needle, the stem of the papyrus into thin plates or slender pellicles, each of them as large as the plant would admit. These were the elements of which the sheets of paper were composed. The pellicles in the centre were the best; and they diminished in value as they receded from it. When these pellicles were separated from the reed, they were extended on a table, and laid across each other at right angles, in which state they were moistened by the water of the Nile, and whilst wet were put under a press, and afterwards exposed to the rays of the sun. It was supposed that the water of the Nile had a gummy quality necessary to glue these stripes together. But, according to Bruce, we may be assured that this is without foundation, no such quality being discovered in the water of the Nile; on the contrary, he found it of all others the most improper, till it had settled and become absolutely divested of all the earthy particles collected in its turbid state. He made several pieces of this paper both in Abyssinia and Egypt; and it appeared to him that the saccharine matter with which the whole juice of the plant was impregnated was that which caused the adhesion of these stripes together, and that the only use of the water was to dissolve this matter, and bring it into perfect and equal fusion. When there was not enough of sugar in the plant, or when the water did not sufficiently dissolve it, the pellicles were united by a paste made of the finest wheat flour, mixed with hot water and a little vinegar; and when dried they were flattened and smoothed by means of a mallet.

The size of this paper varied much; yet it seldom exceeded two feet, and was often smaller. It had different names, according to its size and quality. The first, called *imperial*, was of the finest and largest kind, and used for writing letters by the great men amongst the Romans. The second, called the *Livian* paper, from Livia the wife of Augustus, was next to the imperial, and in size twelve inches. The third sort, called the *sacerdotal* paper, was eleven inches in size. The paper used in the amphitheatres was of the dimensions of nine inches; but it was esteemed on account of its strength, whiteness, and polish. The ink, however, sunk less in paper highly polished, and therefore the characters were more liable to be effaced. When it was not carefully soaked in the first preparation, the paper brought a less price, because letters were with difficulty formed upon it, and it emitted a disagreeable odour. To remedy this defect, the paper went through a new course of sizing and hammering; and the size employed on the occasion was made of light bread steeped in boiling water, and passed through a filtering cloth. By this means the paper became in the highest degree united, and smoother than the finest linen.

It was this paper which gave so long a duration to the works of the Gracchi in their own handwriting. "I have seen them," says Pliny, "in the library of Pomponius Secundus, a poet and citizen of the first rank, nearly two hundred years after they were written." It may be added, that there still remain manuscripts of this paper, which were undoubtedly written a thousand or twelve hundred years ago. It appears from Pliny, that the Egyptians pasted together the pellicles of the papyrus by means of the waters of the Nile; but that the polishing with ivory, and the operations of the hammer and the press, were added by the invention and industry of the Roman artists. The Egyptians seem to have known the use of size; but it is evident from the same author that the Romans used a stronger size in the making of paper. Notwithstanding the care which was taken to give strength and consistency to the Egyptian paper, the leaves, although collected into a book, were too weak to support themselves; and for this reason it was a very common practice to insert a leaf of parchment after every five leaves.

This paper formed an important branch of Egyptian commerce, which continued to increase towards the end of the Roman republic, and became still more extensive in the reign of Augustus. The demand from foreign nations was often so great as to occasion a scarcity at Rome; and in the reign of Tiberius a tumult occurred amongst the people in consequence of this scarcity. In a letter of the Emperor Hadrian, the preparing of papyrus is mentioned as one of the principal occupations at Alexandria. "In this rich and opulent city," says the emperor, "nobody is seen idle. Some are employed in the manufacture of cloth, some in that of writing paper." During the time of the Antonines, this commerce continued to flourish; and Apuleius says that he wrote upon the paper of Egypt with a reed of the Nile prepared at Memphis.

Towards the end of the third century, the demand for this paper became so great, that when the tyrant Firmus conquered Egypt, he boasted that he had seized as much paper and size as would support his whole army. St Jerome informs us that it was much in use in the fifth century, when he flourished. The duty on the importation of this commodity had become excessive towards the end of the fifth or the beginning of the sixth century; and this duty having been abolished by Theodoric king of Italy, Cassiodorus congratulates the whole world on the discharge of an impost on a merchandise which was so essentially necessary to mankind.

Montfaucon and Mabillon mention several fragments written on this paper in the sixth centry. One of these was a charter of the Emperor Justinian, entitled *Charta Plenariæ Securitatis*. In 1698, Montfaucon saw, in the library of Julio Justiniani, three or four fragments of Egyptian paper of the same antiquity; and Mabillon mentions some books of the Jewish Antiquities of Josephus translated into Latin, which seemed to have been written in the same century, and which were preserved in the Ambrosian Library at Milan; but he had not seen the manuscripts. The same antiquary mentions having seen in the library of St Martin of Tours the remains of an old Greek manuscript of Egyptian paper, and which appeared to him to be of the seventh century. He also believes that the copy of St Mark's gospel preserved in the register-house of Venice is written upon the same paper; that it is the most ancient of any of the evangelical manuscripts; and that it may be supposed to have been written at the latest in the fourth century. According to the same antiquary, the Egyptian paper was used in France, Italy, and other European countries, both for books of learning and for public records; and there still remains, he adds, a great number of these in the archives of the church at St Denis, at Corby, in the Abbey de Grasse, and in other convents.

It is probable that the invention of paper made of cotton, of which we shall afterwards treat, insensibly destroyed the reputation and manufacture of the Egyptian paper; but it is still a question at what particular period the fabrication of the latter totally ceased. Eustathius, the learned commentator on Homer, assures us that in his time it was no longer in use; but Mabillon maintains that many of the papal bulls were written on papyrus in the eleventh century. Count Maffei, however (*Histor. Diplomat.* lib. ii.; *Biblioth. Ital.* tom. ii. p. 251), is decidedly of opinion that Egyptian paper was not in use in the fifth century. He considers all records written upon this paper, and dated subsequently to this period, as not authentic; and the papal bulls mentioned by Mabillon, as well as the copy of St Mark's gospel, were, according to him, written upon paper manufactured from cotton. To reconcile in some measure these contradictory accounts, it may be observed, that on some particular occasions, and by some particular persons, the Egyptian paper might have been employed for several hundred years after it ceased to be in general use.[1]

Paper made from cotton.

It is generally supposed that the invention of the paper called *charta bombycina* supplanted the Egyptian paper in Greece. This paper is incomparably more lasting, and better calculated for all the purposes of writing. It is not precisely known at what period this art, which supposes a great variety of previous experiments, was first reduced to practice. The application of cotton to the purposes of paper-making requires as much labour and ingenuity as the use of linen rags; and for this reason, if we would determine the precise time when paper was made from cotton, we should also be able to fix the invention of the art of paper-making as it is presently practised in Europe. Montfaucon proves, by incontestible authorities, that paper made from cotton was in use in 1100. This paper in the Greek language is called χαρτη βομϐυκινος, or βαμϐακινος; for although βομϐυξ is the Greek word for silk, yet in those times it was applied, as well as βαμϐαξ, to cotton; and hence the Italians call cotton *bambaccio*.

The most ancient manuscript of this paper which Montfaucon saw with a date, was that in the French king's library, written in the year 1050; but as the manuscripts without date are infinitely more numerous than those which are dated, and as some conjecture can be formed concerning them from the manner of the writing, the same antiquary believes that some of these were written in the tenth century. The researches of the same learned person serve to show that this paper was discovered towards the end of the ninth or beginning of the tenth century; for before the twelfth century it was commonly used throughout the eastern empire, and even in Sicily. Roger king of Sicily says, in a diploma written in 1145, that he had renewed on parchment a charter which had been written upon cotton paper in the year 1100, and another which was dated in the year 1112. About the same time the Empress Irene, in the statutes for regulating some religious houses at Constantinople, states that she had left three copies of these statutes, two on parchment, and one on cotton paper. From that period paper of this sort became still more in use throughout all the eastern empire; and innumerable Greek manuscripts are found written upon it, in all the great libraries.

This discovery happened at a time when there seems to have been a great scarcity of parchment; for it was about the same period that the Greeks erased the writings of Polybius, Diodorus of Sicily, and many valuable ancient authors, for the sake of the parchment. It was the invention of this cotton paper which destroyed the manufacture of the Egyptian article; for, if we may believe Eustathius, who wrote towards the end of the twelfth century, the latter had gone into disuse but a little before his time. We may easily believe, however, that this new invention, although of great advantage to mankind, was only introduced by degrees.

Paper from the bark of trees.

Paper of the interior bark of trees was made from the white pellicle or inner coat which is found in many trees between the bark and the wood. The trees commonly in use were the maple, the plane-tree, the elm, the beech, the mulberry, and most commonly the linden-tree. The ancients wrote upon this inner coat after they had separated it from the bark, and beaten and dried it. Mabillon and Montfaucon speak frequently of manuscripts and diplomas written upon paper made from bark; and positively distinguish it from the Egyptian paper, because it was thicker, and composed of parts less adhesive.

There are many palm-trees in India and America to which botanists have given the name *papyraceous*, because the natives have written with bodkins either on the leaves or on the bark. Such is the American palm, called *tal* by the Indians; and also the *guajaraba* of New Spain. Every palm, the bark of which is smooth, and the leaves large and thick, may be used for this purpose.

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[1] Whoever wishes for a fuller account of the Egyptian paper, may consult, amongst the ancients, Pliny (lib. xiii.), and Theophrastus (lib. iv. chap ix.); and amongst the moderns, Guilandinus, Scaliger, Saumaise, Kerchmayer, Nigrisoli, Hardouin in his edition of Pliny, Mabillon in his work *De Re Diplomatica*, Montfaucon in his Paleography and Collections; Maffei in his *Histor. Diplomat.*, Count de Caylus in the Memoirs of the Academy of Inscriptions, and Bruce in his Travels to discover the Source of the Nile.

Chinese paper.

The art of making paper from vegetable matter reduced to pulp was known in China long before it was practised in Europe; and the Chinese have carried it to a high degree of perfection. The fine paper of China is much softer and smoother than that of Europe; and these qualities are admirably adapted to the pencil, which the Chinese use in writing. Several kinds of their paper discover the greatest art and ingenuity, and are applied with much advantage to many purposes. These are capable of receiving the impression of types; and Chinese paper is celebrated for affording the most clear and delicate proof-impressions from copperplates.

The different sorts of paper vary in China according to the materials of which they are composed, and the various modes of manufacturing these materials. Every province has its peculiar paper. That of Sechuen is made of linen rags, as in Europe; that of Fo-kien, of young bamboo; that of the northern provinces, of the interior bark of the mulberry; that of the province of Kiang-nan, of the skin which is found in the webs of the silk-worm; and in the province of Houquang, the tree chu or ko-chu furnishes the materials of which paper is made.

The method of fabricating paper from the bark of different trees is nearly the same with that which is followed in the bamboo. To give an idea, therefore, of the manner of manufacturing the interior barks of the mulberry, the elm, and the cotton-tree, it will be sufficient to confine our observations to the bamboo.

The bamboo is a kind of cane or hollow reed, divided by knots, but larger, more elastic, and more durable, than any other reed. The whole substance of the bamboo, composed of filaments, and a great abundance of fibrous materials, are employed in this operation. The shoots of one or two years, nearly as thick as a man's leg, are preferred. They strip the leaves from the stem, cut them into pieces of four or five feet in length, make them into parcels, and put them into water to macerate. As soon as they are softened, which generally happens in five days, they are washed in pure water, put into a dry ditch, and covered for some days with lime watered for the purpose of slacking. They are then washed carefully a second time, and every one of the pieces is cut into filaments, which are exposed to the rays of the sun to dry and to bleach. After this they are boiled in large kettles, and then reduced to pulp in mortars of wood, by means of a hammer with a long handle, which the workman moves with his foot.

The pulp being so far prepared, some shoots of a plant named *koteng* are taken, and being steeped in water four or five days, are reduced to an unctuous or glutinous substance; and when the workmen proceed to make the paper, this is mixed with the pulp in certain fixed quantities, because upon this mixture depends the quality of the paper. When the extract from the koteng is mixed with pulp of the bamboo, the whole mixture is beaten together in mortars till it become a thick and viscous liquor; when it is poured into large tubs or reservoirs, so exactly framed as that no part of the liquor can escape. After this the workmen plunge their forms into the liquor, and take out what is sufficient for a sheet of paper, which, when formed and consolidated, is at once dried and detached from the mould, by being held a moment or two against a heated hollow wall, the two fronts of which are smooth and extremely white. At the extremity of this wall is placed a stove, the pipes of which are carried in a circular manner throughout the whole empty space. The sheets of paper are laid on the surface, to which they adhere till a soft brush is applied to them; and after they become dry, it is easy to distinguish the side which received impressions from the brush from that which adhered to the wall. By means of this stove the Chinese dry their paper as fast as they make it; but it is only in cold seasons, or in certain provinces, that they find this expedient necessary.

The Chinese paper must be dipped in a solution of alum before it can take either ink or colours. They call this operation *faner*, from the Chinese word *fan*, which signifies alum. The manner of preparing this solution is extremely simple. Six ounces of isinglass cut very small are put into boiling water, and constantly stirred, that it may dissolve equally. When the isinglass is wholly dissolved in the water, twelve ounces of calcined alum are thrown in, and also stirred till it is completely dissolved and mixed with the isinglass. This composition is afterwards poured into a large deep bason, at the mouth of which there is a little round piece of wood; and the extremity of every sheet of paper is then fixed in another piece of wood, with a slit made to receive it. By means of this apparatus the sheet of paper is plunged into the composition of alum and isinglass; and when it is fully penetrated by the mixture, it is drawn out, and made to glide over a little round piece of wood. The long piece of wood which holds the sheet by one end, and keeps it from tearing, is afterwards suspended with it on a wall till it becomes sufficiently dry.

The Chinese give to the paper intended for different purposes different colours; but we shall confine our observations to the silver colour, which they impart to some kinds. They take two scruples of paste made of cow's hide, one scruple of alum, and a pint of water, and boil the whole on a slow fire till the water be evaporated. The sheets of paper are then stretched on a smooth table, and covered over with two or three layers of this paste. They afterwards take a certain quantity of talc, washed and boiled in water, with a proportion of one third of alum. The whole is then dried, reduced to a powder, passed through a sieve, boiled a second time in water, dried in the sun, and again passed through the sieve. This powder is then spread equally over the sheets of paper, prepared as above mentioned; and these are afterwards dried slowly in the shade. The sheets of paper, covered in this manner with talc, are laid upon a table, and rubbed with a little cotton, which fixes a certain quantity of talc in the paper, and carries off the surplus to be used on another occasion. By means of this composition the Chinese draw all manner of figures on their paper.

The paper made from the bamboo is sufficiently white, soft, and closely united, without the least inequality on the surface to interrupt the motion of the pencil, or to occasion the rising of the materials which compose it. But every kind of paper made from the bamboo or the bark of trees is more liable to crack than that made in Europe; besides, it is more susceptible of moisture, and is sooner destroyed with dust and worms. To obviate this last inconvenience, people are obliged frequently to beat their books in China, and to expose them to the sun. It may be observed, however, that the Chinese paper, employed for various purposes in Europe, has been preserved for a long time without receiving damage either from moisture or from insects.

Japanese paper.

According to Kæmpfer, the bark of the *morus papifera sativa*, or true paper-tree, is chiefly employed for making paper in Japan. Every year, after the fall of the leaves, which happens in the tenth month, corresponding to our December, the Japanese cut the young shoots of this tree into pieces of about three feet, and collect them into parcels, which they boil in water containing a certain quantity of ashes. If the wood be dry, they take care to steep it twenty-three hours in water before it is boiled. The parcels are kept in a close copper till the bark at the extremity of the shoots is separated from the stem about half an inch; they are then cooled, and the bark alone is fit for making paper. They begin by a preparation, which consists of cleaning the bark, and separating the good from what is bad. For this purpose they steep it in water three or four hours; and as soon as it is softened they scrape off with a knife whatever is blackish or green, and at the same time separate the strong bark of a year's growth from the slender kind which covers the young shoots. The first of these gives the whitest and best paper. If there be any of the bark of more than a year's growth, it is laid aside for the coarsest kind.

After the bark has been culled and cleaned in this manner, it is boiled in a clear ley till the matter is of such consistency, that, being gently touched with the finger, it draws off in the form of hairs, or like a collection of fibres. During the time of boiling it is constantly stirred with a strong reed, and the waste by evaporation is supplied from time to time with additional quantities of the clear ley. To make this ley, they put two pieces of wood across the mouth of a tub, and cover them with straw, upon which is laid a bed of ashes a little moistened; and when boiling water is poured on the ashes, the salts contained in them are carried down to the tub. This is what is called a *clear ley*. After the bark is in the condition which we have just stated, it is washed with great care; for on this washing depends in a great measure the quality of the paper. It is put into a kind of sieve through which the water can flow freely; and great care is taken to turn it with the hand till it be sufficiently diluted, and reduced to soft and tender fibres. For the finest paper a second washing is requisite, and a piece of cloth is used instead of a sieve.

When the bark is washed, it is laid upon a strong and smooth table, and beaten with a kind of baton of hard wood till it is reduced to a proper consistency. Indeed it becomes so soft that it resembles paper steeped in water. The bark prepared in this manner is put into a narrow tub, with a glutinous extract from rice and the root *oreni*, which is very viscous. These three substances are mixed together, and stirred with the reed till they form a liquor of uniform consistency. The composition is then poured into vats similar to those used for filling the forms or moulds in our paper-mills.

As soon as the sheets are made and detached from the form, they are laid in a heap upon a table covered with a double mat. A small chip of cane is placed between every sheet, and this jutting out serves to distinguish the sheets, and afterwards to raise them. Every one of the heaps is covered with a plate or thin board of the exact size of the paper. In proportion as the paper dries, or is able to bear it without danger of being compressed into one mass, they lay on additional weights. This pressure, being intended to carry off any unnecessary moisture, is continued during twenty-four hours, when the sheets are, by means of the little pieces of reed, suspended to long plants in the open air, till they are completely dried.

The extract from rice is made in an unvarnished earthen pot, which is at first agitated gently, and then more briskly; new water is next poured in, and the whole is filtered through a linen cloth. The finishing of the process is determined by the viscosity of the substance. The infusion of the root *oreni* is prepared in this manner: The root, peeled and cut into small pieces, is infused in water for one night, during which time it communicates a viscosity sufficient for the purpose to which it is applied.

The Japanese paper is of such prodigious strength, that the materials of which it is composed might be manufactured into ropes. There is sold at Serige, the capital city of the province of that name, a kind of paper which is fit for bed-hangings and wearing apparel, and so much resembles stuffs of wool and silk that it is often taken for them. There are four trees used in Japan for the manufactory of paper:—1. The true paper-tree, called in the Japanese language *kaadsi*, and characterized by Kæmpfer as *papyrus fructu mori celsæ, sive morus sativa foliis urticæ mortuæ cortice papifero:* 2. The false paper-tree, called by the Japanese *katsi* or *kadsire*, and by Kæmpfer *papyrus procumbens lactescens folio longo lanceata cortice chartaceo:* 3. The plant which the Japanese call *oreni*, and which is named by Kæmpfer *malva radice viscosa flore ephemero magno punico:* 4. The *futokadsura*, named by Kæmpfer *frutex viscosus procumbens folio telephii vulgaris emulo fructu racemoso.* The description of these trees, as given by Kæmpfer, may be of service in leading botanists to discover the European plants and shrubs adapted, like the Japanese, for the fabrication of paper.

Before concluding this part of the subject, it may be proper to give an idea of the attempts which have been made to increase the original materials of paper in Europe. A slight attention to the Chinese process in reducing the bamboo to a paste, by a careful and ingenious analysis, and to the method employed by the Japanese in separating the principal fibres of the bark of the mulberry, will show the absurdity not only of taking plants without any kind of choice, but of giving them no preparation, except that of pounding them with mallets. With a proper selection and right treatment, it appears probable that many of the European plants might be used with great advantage in fabricating several kinds of paper. It is evident that the materials used by the Chinese require less labour and preparation than the stuff of linen rags. The sheets of the Chinese paper are easily detached from the form; they are laid in heaps, without the interposition of pieces of woollen cloth; the superfluous water is immediately discharged; and they require not, as in Europe, the vigorous action of presses to unite the parts more closely together.

Paper made from asbestos.

Asbestos is a fibrous substance of little strength, and the threads of which are easily broken. This substance has the peculiar property of supporting the action of fire without receiving any damage; and hence pieces of cloth and garters made of it are incombustible. From the knowledge of this property, paper has been made of asbestos. The manner of fabricating this paper is described by Mr Lloyd in the *Philosophical Transactions* (No. 166). A certain quantity of asbestos is pounded in a stone mortar till it be reduced to a substance like cotton. All the parts of earth or stone remaining in the asbestos are then taken off by means of a fine sieve, and it is formed into sheets of paper by an ordinary paper-mill. Mixing it with water reduces it to stuff; but as it is heavier than that made from linen rags, it requires to be continually stirred when it is taken up with the frames. The only excellence of this paper is, that the writing disappears when cast into the fire. But as it is of a slender consistency, and easily torn, it is rather an object of curiosity than of use.

Paper made from rags.

This paper is manufactured throughout all Europe, in the East Indies, and in America, from linen and cotton rags collected in the cities and in the country. Paper made of linen rags was utterly unknown to the ancients. The *libri lintei* mentioned by Livy (i. lib. iv.), Pliny (lib. xiii. c. xi.), and other Roman writers, are demonstrated by Guilandin, in his commentary on Pliny, to have been written on pieces of linen cloth, or canvass prepared in the manner of painters. But it is not sufficient to be certain that paper made from linen is a modern invention; it is necessary to know by what nation, and at what period, it was discovered. Polydore Virgil (*De Inventoribus Rerum*, c. ii. c. viii.) confesses his ignorance of this circumstance. Scaliger, without any kind of proof, gives the credit of the invention to the Germans; and Maffei claims it for the Italians. Other writers ascribe this honour to some Greek refugees at

Basil, to whom the manner of making paper from cotton in their own country had suggested the idea. Duhalde is persuaded that Europe derived this invention from the Chinese, who, in several provinces, make paper of rags nearly in the same manner as we now do. But this invention was practised by the Europeans before they had any communication with China, and before the taking of Constantinople, at which time the Greek refugees were supposed to have retired to Basil. The precise date of this discovery in Europe is not exactly known. Mabillon believes that it took place in the twelfth century, and cites a passage of Pierre de Clugny, born in the year 1100, to prove it. The books which we read every day, says De Clugny, in his treatise against the Jews, are written on sheeps' and calves' skins, or on oriental plants, or, finally, *ex rasuris veterum pannorum*. If these last words signify paper such as we use, there were books of it in the twelfth century. But this citation is the more to be suspected, as Montfaucon himself, after the minutest search in France and Italy, could find no book on this paper anterior to the death of St Louis, in the year 1270.

The epoch of this invention was not approximately determined till 1762, when M. Mierman proposed a reward to the person who could procure the most ancient manuscript written on this kind of paper. The collection of all the memoirs sent to him, along with the manuscripts, was published at the Hague in 1767; and it appeared that this paper had been used in Europe before the year 1300.

In 1782 the Abbate Andrez published a work, entitled *Dell' Origine, Progressi, e Stato attuale d'ogni Letteratura*, in which he speaks of the discovery of many kinds of paper, and particularly of that made of rags. The same person maintains, that paper made from silk was very anciently fabricated in China, and in the eastern parts of Asia; and that the art of making this paper was brought from China to Persia about the year 652, and to Mecca in 706. The Arabs substituted cotton, the commodity of their own country, instead of silk, or rather of bamboo. This cotton paper was carried into Africa and Spain by the Arabs. The Spaniards, from the quantity of linen to be found in the kingdom of Valencia, seem first to have adopted the idea of using linen rags; and hence the most ancient paper of this kind is that of Valencia and Catalonia. From Spain it passed into France, as may be gathered from a letter of Joinville to St Louis about the year 1260; and it is discovered to have been made in Germany in 1312. The first paper-mill in England was erected at Dartford by a German named Spielman in 1588, who was knighted by Queen Elizabeth. In consequence of paper made from cotton being imported from the Levant, paper made from linen was introduced much later into Italy, than into France, Germany, and England.[1]

Art of paper-making in Europe.

This manufacture owes, in a great degree, the prodigious advancement which it has attained in Great Britain during the last thirty years, to the ingenious and successful application of machinery. Many of its formerly tedious and uncertain processes are thereby greatly simplified and abridged; a remarkable instance of which is the improvement of cylinder-drying. The drying process used formerly to be effected mainly by the agency of the atmosphere; but since the paper-machine was perfected, the paper is now made to pass in the web, as it is formed, over the surface of a certain number of metal cylinders heated internally by steam, and is dried off in less than two minutes, whereas it was formerly exposed in the winter season to the frequent occurrence of being for weeks or months kept in a damp state, or exposed to severe frost, to its certain and great damage.

The manufacture naturally divides itself into that which is carried on in *hand-mills*, where the formation of the sheet, as formerly, is still performed by manual labour; and that which is carried on by *machine-mills*, where the paper is formed upon the machine wire-cloth in one continuous web. To give a distinct view of the subject, it will be necessary to describe all the important parts of the operation in their order, most of which are common to both modes of manufacture.

Materials.

The materials principally used in Great Britain are old linen and cotton rags, which are collected in great quantity at home. A large quantity of rags, chiefly linen, is annually imported from the different countries whence the exportation is not prohibited, viz. Germany, Italy, Sicily, and Hungary. Within the last ten years a very abundant supply of material, formerly considered as totally worthless, has been obtained from the cotton factories in Manchester and its neighbourhood; we allude to the cotton waste, and sweepings of the cotton-mills, which, by being *devilled*, that is, cleaned by a machine used in the cotton manufacture called a devil or skreening machine, and afterwards boiled in alkaline solution, and bleached, are capable of being converted into very tolerable printing paper.

The selection of the rags, if it should not have been performed before they are brought to the paper-mill, is there performed by women sorting them into their various qualities, which facilitates the work of the rag-cutters, whose business it also is to sort the rags into their different kinds as they cut them. The rags are then assigned, in bags or bales of from two to five hundredweights each, to the women in the rag-house. These women stand at small tables of about three feet square, the upper surface being composed of iron wire cloth, the meshes of which are about one fourth of an inch square, whilst underneath there is a drawer. A knife or short scythe is firmly fixed in the centre of the table, in nearly a vertical position, and the woman is placed so as to have the back of it standing next her, and with a large wooden box divided into several compartments upon the floor, on her right hand. She then opens and examines the seams and patches of the rags, and removes the dirt, as well as any other noxious substances, such as pins, needles, buttons, silk and worsted pieces, &c. that may be attached, which would be hurtful to the machinery, as well as to the quality of the paper. She cuts the rags, by drawing them to her across the edge of the scythe, into pieces not exceeding four inches square, which are sorted and thrown into the boxes above referred to, according to their different qualities. A great deal of the dirt, sand, &c. passes through the wire-cloth into the drawer of the table, which is opened and cleaned out at convenience.

The rags, after being thus cut and sorted, are again carefully examined by women called *overlookers* or *overhaulers*, who have the charge of seeing that the work is properly performed, and that none of the noxious substances above referred to are allowed to remain in the rags. Much of the beauty and cleanliness of the paper, when finished, depend upon due attention being insisted upon in this department; for any dirty or noxious substances, when once comminuted by the trituration of the *stuff* into an endless number of small particles scattered over the surface of the paper, are of course wholly fixed and irremoveable.

Several machines have of late years been invented for the purpose of cutting rags, and thereby abridging the labour and expense. By means of rollers they are carried round a large cylindrical drum, on which knives, placed diagonally, revolve with considerable velocity and power, and cut the rags into small diamond-shaped pieces. But such machines have hitherto been found of comparatively little service, as of course they cannot perform the work of selection, or the removal of the impurities from the material, which can only be done by careful and close examination at the time of cutting the rags, and with the advantage of using the sharp knife to cut or scrape off the injurious portion. These rag-cutting machines, moreover, have been apt to cut the rags into very unequal sizes, leaving one portion much too large, and another portion much too reduced, for the due trituration of them afterwards.

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[1] See the work of Abbate Andrez, printed at Parma, 1782, in 8vo; and Mierman's Collection, published at the Hague.

After the rags have been cut and carefully examined, they are enclosed in a cylinder called a duster, the whole circumference of which is composed of iron wire cloth; it measures about four feet and a half in diameter, and is about five feet in length; and a part of the circumference opens on hinges to admit the rags, from one to two hundredweights of which are generally enclosed at a time, and remain in motion for half an hour or an hour. On the axis in the interior of the cylinder there are a number of spokes, each about one foot long, fixed transversely, which pass through the rags when they are in rapid motion, and toss them about so as to make them part the more readily with the dust, sand, and dirt, which may still adhere to them. For the coarser and dirtier descriptions of rags this machine is used with good effect before they are cut, and renders the operation of cutting the rags less accompanied with dust, &c., and therefore less unpleasant and unwholesome to those engaged in it.

The women engaged in the rag-house cut on an average about three quarters of a hundredweight of home rags, that is, rags collected in Scotland and England, in the day of ten working hours, and about one hundredweight and a half of foreign rags in the same time. This arises from the latter being of a much heavier and stronger substance, generally speaking, than the former. Their wages amount to from tenpence to a shilling per day on an average. The nature of their employment, though it subjects them to the inhalation of dust and fibrous matter floating through the air, does not seem at all to injure their health, nor to warrant the adoption of what medical men have sometimes volunteered to recommend, that of breathing through sponges placed over their nose and mouth, to prevent injury to their chests and lungs.

The next process is that of boiling the rags in an alkaline ley, which is rendered proportionally strong, according to the lowness of the quality of the rags and the quantity of the colouring matter to be discharged. In some mills large open-mouthed coppers, with fire under them, are used for this purpose; in others, where there is a full command of steam, the rags are boiled in large square iron boxes, capable of containing ten or twelve hundredweights at a time. Part of the lid is made to move on hinges, or with a rope and pulley and balance-weight, for the purpose of the rags being placed in and taken out of the vessel; and before the steam is allowed to pass into the chest, the lid is secured by being screwed tightly down, and the joints of it formed by oakum to prevent the blowing of the steam. The steam passes through an upright iron pipe of about an inch and a half in diameter, through the centre of the lid down to the bottom of the chest, whence it diverges through a number of pipes or radii towards the sides of the chest. There is a false bottom, also of iron, which is in moveable pieces, about six inches above the real bottom; it is perforated by a number of small holes, to allow the boiling ley to pass constantly through the mass.[1]

The quantity of alkaline matter varies from four to ten pounds of carbonate of soda to each hundredweight of rags, according to their quality, with about one third part additional of quicklime, to render the ley caustic. The boiling is carried on upon an average for about eight hours, after which the rags are cooled as gradually as possible, since the process of cooling, if rapidly carried on, tends to fix some of the black colouring matter again in the rags. Some makers use only lime in the boiling process, whereas others use pot and pearl ashes to a considerable extent; but we believe that a ley composed of soda and a portion of quicklime is most commonly employed.

The rags, after being thoroughly cooled, to which a gentle flow of cold spring-water let into the boiler materially contributes, are laid aside in large wooden chests for use, or at once conveyed in boxes on wheels into the engine-house, there to be reduced to pulp. As this is one of the most important processes, and requires the whole power of the mill, we shall explain it, with reference to Plate CCCCIII. This plate represents a plan and elevation of a paper-mill for four engines, EE. W is the water-wheel, on which there are segments, S, of cast iron, which work into a main pinion P. This pinion is fixed on the same lying shaft on which the spur or fly-wheels F are also hung. The motion is thus brought up to the proper speed, it being necessary that the pinions *p*, *p*, *p*, of the engines, and the engine-cylinders *c*, *c*, should perform about 150 revolutions per minute.

The engines, fig. 1, which are to be understood as large troughs of an elliptical form, with a division *d* running nearly the length that intervenes between the foci of these imaginary ellipses, consist of two sorts, according to the purposes to which they are applied, viz. washing and beating engines; the former being designed for washing and rubbing out the rags, and the latter for shortening or beating down the fibres, after the washing and bleaching processes have been performed.

These engines are generally made of strong wood, and lined inside with lead or copper; but for some years past they have been very successfully cast in iron, all in one piece, although, from their awkward shape, it may be easily conceived to be rather a difficult matter to insure a good casting of such a mass. They measure about ten feet in length, four and a half feet in width, and about two and a half feet in depth, being dimensions sufficient to contain about 112 or 120 pounds of rags. From the rapid motion and weight of the machinery, and great friction necessary to triturate the stuff, it is evident that the solid fixing of the engines is a matter of extreme importance. It is usual, therefore, to build, from a solid foundation, a substantial mass of ashler work (fig. 2, A A), of the size of each engine, for it to rest upon.

The cylinders in the engines, technically called the rolls, and by the revolution of which the rags are ground into pulp, are formed in general of solid wood. Elm is most generally used for this purpose. They are commonly about two feet in diameter, and two feet in length. Round the circumference are firmly fixed bars of steel parallel to the axis or spindle, in bunches of two together in the washing engine, and three in the beating engine, generally about eighteen or nineteen several bunches, and making therefore in all about thirty-eight bars in the washing engine cylinder, and fifty-four or fifty-seven in that of the beating engine. These steel bars are sunk and wedged into the circumference of the cylinder, parallel to the axis, and are, moreover, firmly fastened by means of hoops, which are fitted into a groove in the ends of the cylinder, and, passing through the bars at a place cut out in them for that purpose, secure them firmly in their place.

Under the cylinder is what is called a plate, see fig. 2, that is, a number of steel bars, which lie fixed in a place

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[1] A sketch of a chest of this description will be found under the article Bleaching, vol. iv. p. 683.

provided in the trough *b* for them. They are accurately fitted, so as to form a segment of the same circle as the cylinder itself. The number of bars varies according to the kind of work performed at the mill; but in white-paper mills, in the washing engines, the plate has generally from twelve to eighteen bars, and in the beaters from twenty to twenty-four. The breadth of the plate is almost universally the same everywhere, namely, from five and a half to six inches. A plate six inches broad is found to require quite as much power, from the increased friction, as can in general be spared.

The thickness of the bars in the washing-engine plate is generally from about three eighths to half an inch; and in the beating engine from about three sixteenths to one fourth of an inch. In the latter they are made up with wooden or copper dividers, so as to afford the necessary thickness, in all of five and a half or six inches. The thickness of the cylinder and plate-bars ought to be about the same proportion to each other: they are bevelled or tapered off about an inch or an inch and a half from the edge, like a wedge; and those in the washing engine being intended for opening and rubbing out the cloth and duly washing it, it is the opinion of the writer of this article that they ought not to be under the thickness of one eighth of an inch, and in the beaters under that of a shilling at the edge after being ground, otherwise, by the too rapid conversion into pulp, the strength of the fibre would be materially injured.

The rags having now been boiled, and brought into the engine-house, the workman, or engineer as he is called, fills the engine or trough about half full of water, till the bars of the cylinder, which project fully an inch from the wood, get hold of the water, and begin to turn it round. He then begins to put the rags into the engine, and spreads them with his hand. By Plate CCCCIII. fig. 2, it will be seen that the spindle *s*, which goes through the cylinder, is supported in its bearing upon an iron lever, called a lighter, *l*. A screw *h* is attached to it, and by moving that screw, the cylinder can be raised about three inches above, or depressed so as to come into contact with the bars of the plate.

Behind the cylinder it will be found that there is a rise (fig. 3, *r*) in the trough, which, on the side next the cylinder, forms a segment of a circle similar to that of the cylinder, and within an inch or two from it, and then descends by a rapid declivity from the point *t* to the natural bottom. This rise is called by the workmen the *backfall*, from the rags falling down upon it. The cylinder is always, when the mill is at work, enclosed in a wooden cover, fig. 4. The cover of the washing engine has four slits or grooves cut down through the top of it, two on each side of the cylinder. The two slits *w* next the cylinder are made for a board of wood *w*, which can be put in or removed at pleasure, being guided by grooves in the inside of the cover. The other two slits *c* receive two frames of very fine copper-wire cloth *c*, having about 4900 holes in every square inch. These wire-cloth frames are generally fixed, being only taken out when any repairs are requisite.

The rags being now filled into the engine, the cylinder, by means of elevating the screw (fig. 2) *h*, is raised as high as it will go, as there is thereby room for a greater quantity of water being carried round with the dirty rags, and driven by it, in its rapid revolutions, against the wire-cloths. In the bottom of the trough, see fig. 1, there is a false bottom *f*, which is punctured through by a number of small holes, and which communicates with a cock O. This cock, when kept fully open for the first twenty or thirty minutes, has the effect, in consequence of the pressure of water and suction, of carrying off a great deal of dirty water, as well as sand and loose particles from the rags, which have escaped former cleaning operations.

When the engine has been once filled with rags and water, of which there must be a large supply constantly flowing, the cylinder, by its projecting bars, working like the paddles of a steam-boat, draws them in. It then throws them up to the top of the back-fall formerly alluded to, dashing a portion against the two wire-cloths, through which the dirty water passes, and the rags or stuff remain. A great portion of course descend the inclination at the back-fall, and by this means produce a regular progressive motion of the stuff, which comes again and again under the action of the cylinder bars and plate. The cylinder is gradually depressed as the washing goes on, till it comes as nearly as possible in contact with the plate at its lowest point. The plates are not placed directly in line with the bars of the cylinder, but lie at an angle of about five degrees. This prevents the one from being locked against the other, should the cylinder, from any cause, be too much depressed; and it is moreover necessary that they should be in that position, to promote the reducing of the rags to pulp, on somewhat of the same principle with the cutting process performed by a pair of scissars, the one blade forming an angle with the other.

To make good paper, a great deal depends upon the state of the engines, bars, and plates. If these be not in proper working order, and well fitted together, and adapted for the description of material worked, it is impossible that any subsequent care can remedy the mischief done in the engine-house. It is much to be regretted that the great demand which has prevailed for paper for many years past has induced manufacturers generally to sacrifice quality to quantity, by hurrying the process, which impairs the strength of the fibre, and injures the texture of the paper.

Mr John Murray of Hull has paid considerable attention to the state of modern paper, and has contrasted its condition with that which was made thirty or forty years since, greatly to the disadvantage of the former. Mr Murray, who has pointed out the value of the *Phormium tenax*, or New Zealand flax, as a substitute for hemp in making cordage, and who has also printed and published a pamphlet (in 1836) upon paper made of its leaves, which, though coarse, is remarkably strong, thus writes, in a postscript appended to that work:—"The unquenchable rage for bleaching that now prevails is carried to an extent altogether irrational, and which our calmer judgment would condemn if suffered to interpose. Paper, when bleached, if the chloride be not removed, or permanently neutralized, produces effects of the most disastrous kind." Mr Murray then refers to a number of recent publications, which, he alleges, are rapidly crumbling into dust; and seems to attribute the whole evil to excessive bleaching. Whilst we admit the ruinous effect on the fibre, of bleaching to excess, and whilst we also admit that there is much truth and justice in Mr Murray's remarks, we do not share, to the same extent, in the alarm which he experiences in contemplating the speedy ruin of the books and manuscripts of the present day; and we are rather disposed to attribute the evil complained of, not by any means so much to excess of bleaching, as to the hasty preparation of the stuff in the engines.

In any former treatises on paper-making which we have seen, we observe that the trituration of the rags is described as an operation of cutting. If the bars and plates of the washing engines are kept so sharp as to cut the rags, nothing can be conceived more injurious. Every paper-maker knows that the stuff is rendered mellow and soft, by being rubbed out by blunt bars and plates. The longer the time occupied by this operation, the more water will the stuff incorporated with it hold when it is worked into paper, and the less easily will the water drain off from it, which is always a sign of strong paper. Stuff, on the other hand, which has been quickly prepared by sharp tackle, never has the water properly beaten up with it; but the fibres, having been *cut* down, as it were, are held in suspension in the water merely, and the paper made from such stuff is always weak, flimsy, and perishable.

An abundant supply of fine water is very essential to produce paper of fine quality. When the rags are first begun to be washed, the engine consumes about a hogshead per minute for the first half hour; but this quantity is soon diminished by the rags being opened up into pulp, and thereby taking up more room for themselves in the engine, till, towards the conclusion of the washing process, the water which passes through the wire-cloths does not amount probably to one-twentieth part of that quantity.

In reducing the rags to half stuff, about three or four hours have been hitherto considered as necessary for fine papers; but, from the desire to produce a large quantity, it is the practice of most machine-mills now to do this in half the time, to the very great injury of the fabric. The power required to keep each of the cylinders moving the stuff, when pretty near to the plate, is equal to about five horses.

The rags having undergone the process of being washed and *broken in*, that is, rubbed into half-prepared pulp, the engineer shuts off the supply of washing water, and then, by means of an iron hook two feet and a half long, which he inserts into the cavity of a conical brass valve, fitted into a pipe at the bottom of the trough or engine, raises that valve, and the half stuff then flows through a pipe of about six inches diameter, into the bleaching-house, situated in the under story, where it is received into a draining-chest of pretty large size, and suffered to part with the water, which flows through a number of very small holes bored in the wood. As soon as the stuff is emptied, the washing-engine is again filled with rags, as before.

The bleaching process is carried on in some mills by the rags being subjected in close chambers to the action of chlorine, which is produced in leaden retorts, from sulphuric acid, sea-salt, and the black oxide of manganese, and for an account of preparing which, we refer to the article BLEACHING. In a great many mills, however, where this mode was long carried on, it has been entirely abandoned, and the practice of steeping the rags in a solution of chloride of lime has been very generally substituted, particularly in Scotland. The advantage, in the latter process, consists in the stuff not being so much injured in the fabric as if exposed to chlorine itself; and although the whitening effect may not be produced so speedily or completely as if done by the action of the gas, yet, by giving the steeping process plenty of time, that is nearly compensated for, and there is much less waste in the latter than in the former process.

The bleaching house for steeping consists of a long apartment, according to the number of sheets necessary for the extent of the works, and about sixteen feet wide. A passage of three or four feet wide goes down the middle, and on each side are arranged stone chests about three feet deep, and containing about fifty-seven cubic feet. In each there is a false bottom, which has been made of many different materials, none of which is so good as could be wished, to resist the action of the chloride, and which, therefore, require frequent renovation, viz. lead, copper, wood, stone, slate, &c. The false bottom is pierced through with a number of holes, as small as can be made; and under the false bottom there is a small pipe, into which a valve is fitted, and attached by a wire reaching up to the top of each chest, by pulling which, the liquid is allowed to escape at pleasure into a large tank, extending under the whole of the chests. In this tank is sunk a pipe, with a pump, for the sake of raising the liquor. Although this solution be now very weak, yet it is much better than pure water, and therefore it is so far eligible to make use of it.

The half stuff having come down from the washing engine into the draining chest, which is situated about three feet higher than the level of the stone bleaching chests, and being now freed by drainage of a great part of the water with which it descended from the engine, a part of one of the sides of the draining chest, being a kind of door on hinges, is opened, and the stuff is promptly raked into an iron square box lined with wood or metal, which moves on a railroad fixed along the passage above referred to, and is carried to each of the chests in succession, as they are ready to receive the stuff. About one hundredweight of rags is laid in each chest, and receives upon an average from six to eight pounds of Tennant's strong saturated chloride of lime, according to the quality of the rags, in solution with about twelve gallons of water; and the chest is then nearly filled up with the weak liquor pumped from the tank. Great care is necessary to keep the stuff frequently stirred, otherwise the whitening throughout would not go on regularly. It is always found, that from the effect of the air and light, the upper stratum of the stuff in the chests becomes white, whilst what is under is for some time but little affected.

The stuff is allowed to remain in the steep for twenty-four hours before the liquor is allowed to drain off, and of course there must be as many chests as there are hundredweights of stuff prepared in the twenty-four hours; but it is found not to have reached its maximum of whiteness even in twenty-four hours, for the stuff which has been set to steep on Saturday, is always found on the Monday mornings to be of a somewhat purer white than on any other morning.

After the time for steeping has expired, the stuff is again lifted into the iron box formerly mentioned, which, being full of stuff, is moved on the railway till it is placed on a moving sole of a Bramah hydraulic press, which is situated in a convenient part of the passage; and the water being injected by pumps moved by the machinery of the mill into the piston of about ten inches diameter, causes by its great pressure the iron sole, with the wet bleached stuff upon it, to rise against a wooden *ram*, as it is called, of the exact size of the box containing the stuff. What remains of the chloride in solution, as the ram enters into the box, is thus gradually pressed out, and flows into the tank formerly mentioned as situated under the chests. The ram enters into the box about one half of its whole depth, and it will be seen by the annexed table what space is occupied by a hundredweight of the material in its raw and manufactured state at different stages of the process.

One hundredweight of linen rags cut, but not pressed, occupies a space of about..	5½ cubic feet.
When in the washing engine in process of washing..	46 ...
When drained of all the water that will flow from it..	25½ ...
When pressed by the ram........................	7½ ...

The object of pressing out the liquid weak chloride of lime is to lighten the labour of raising the stuff to the higher story of the engine-house again, and also to render the process of washing it out the more easy; for it is most essential that none of the bleaching matter should be left in it.

This washing is performed in precisely the same way as that of the rags, and goes on for about an hour, after which, in the same engine, the pure water being shut off, and the boards in the cover of the engine being put into their places, the pulp is reduced considerably in length of fibre in the same engine with *blunt* tackle, which tends to soften the stuff, and make it mellow. The engine which is specially set apart to wash out the remains of the chlorine, and to soften the stuff, is sometimes called the intermediate engine; the stuff being now half way between rags and paper, and called *half stuff*.

The stuff is then let down to the beating engine by lifting a valve in the pipe, and it is then beaten down by tackle considerably sharper than that in the washing engines. The stuff is here, as it were, combed out into fibres of perhaps one eighth of an inch in length, and this operation for fine paper ought to take from four to five hours; and, from the friction between the cylinder bars and those of the plate, the stuff ought to become moderately warm. It is now in a condition to be made into paper; and, by a valve being lifted, it flows out of the beating engine by a pipe which conducts it to a large stone or wooden reservoir called a chest in the vat-house or machine-house.

Making paper by the hand.

The apparatus for the formation of the paper in single sheets at a time by the hand consists of,

1. A chest for receiving the prepared stuff, and which, if there be enough of fall in the situation, it is extremely desirable to have situated about three feet higher than the vat, in order that the stuff may flow from the chest to the vat gradually as it is worked into paper, otherwise it must be lifted by a lad at intervals by means of a copper pan.

2. The vat, which is a stone vessel about six feet square, and about four deep. It is agitated by a *hog* or little wheel about twelve inches in diameter, which revolves through the whole length of it to keep the stuff constantly stirred; for the fibrous particles, being heavier than water, would otherwise sink.

3. The moulds or frames, of which a pair is required, so that when the vatman is dipping the one into the stuff, the coucher may be placing the sheet on a layer of felts, of which from four to eight quires, according to the size of the paper, form a *post*, that is, the whole quantity which is brought under the press at one time. The vatman stands at one side of the vat, and the coucher at the far corner of the side, on the vatman's left hand, and facing him; and between them is a narrow ledge of wood, on which the mould is sent from the vatman to the coucher. The vatman always holds in his hand a frame of wood called a *deckle*, which is about an inch broad, and is made to fit exactly all round the edge of the mould, for the purpose of forming a clean and not a ragged edge to the sheet; it is this which is called the water-edge, and which is so easily distinguishable from any other species of edge than can be otherwise produced as to have been generally adopted in paper used for bank-notes. This description of paper is in consequence generally made on moulds of the size of the note, that it may possess the water edge, for the purpose of rendering forgery more difficult.

The moulds are made of brass wires or wire-cloth fixed upon a wooden frame, which is generally made of mahogany. A number of wooden ribs are fixed across the frame, placed at intervals of about one inch from each other, for the wires or wire-cloth to rest on. When *wires* only are used, these are *laid* longitudinally along the frame and across the wooden ribs, and interlaced with a wire somewhat thicker than the wires running lengthways, which is placed on the top of each rib. Paper made on such moulds is called *laid*, in contradistinction to what is made off the *woven* wire-cloth, and which is therefore called *wove* paper.

When the vatman dips the mould into the vat with the deckle upon it, he takes up a quantity of the pulp, which has been previously mixed with a great deal of water, and well agitated by the *hog:* he then throws off a great portion of the stuff and water over the edge of the mould farthest from him, and bringing the mould to a horizontal position, shakes it to and from him, which connects the fibres together so as to form one uniform fabric, and shakes out the water. To attain this method perfectly requires a long apprenticeship, simple as it may seem. As soon as the pulp is no longer in a liquid state on the mould, the workman raises the deckle with his fore-fingers and thumbs from off the mould, and with his remaining fingers shoves the mould along the ledge before referred to, to the coucher, who is ready to receive it, and who places it in an inclined position upon a small wooden curved stay, on which it reposes for a few seconds, that the water may be further drained from the newly-formed sheet. The coucher is in the mean time pitching a felt or piece of blanketing upon a wooden plank of the proper size, and then takes the mould and presses the face of it upon the felt, which receives and takes off the sheet of paper from the mould, still in a very wet state. The mould, being now freed of the sheet formed upon it, is pushed back along a wooden bridge, as it is called, which is joined to the ledge, and is placed at right angles to it. The bridge crosses the vat in front of the vatman, and the mould lies on it ready to be used by him, whilst the other mould is employed by the coucher. The process is continued till all the felts, being placed above each other with a sheet between each, are employed, which takes about half an hour. A heavy plank is then placed on the top of the *post*, as this quantity is called, and the whole is drawn in on a railroad, or rollers, under a press which is contiguous, and where the water is squeezed out, either by means of a screw, or by a Bramah hydraulic press. The paper, when it comes out of this press, is so coherent as to admit of being handled, and the sheets are accordingly laid together in a pack by themselves, the felts being placed on a wooden deal between the person who takes off the sheets from the felts, called the layman, and the coucher, who immediately, with the aid of the vatman, begins a new post. The water-mark is produced by wires in the shape of the letter or design being raised upon the surface of the mould.

After a number of packs have been made, they are put into another press, where they are made to *sweat* by pressure; that is, just to part with a small quantity of water, which comes from them in single drops. If the pressing be carried on too quickly or too long, the paper would be damaged by the sheets adhering to each other, and *peeling* or tearing when attempted afterwards to be separated.

The paper is then parted sheet by sheet, so as to be enabled to undergo another pressure before it goes to the loft to be dried. In fine writing paper it is the practice to part the paper twice over, pressing between each parting. This is to make the sheets lose the marks of the felts, and to get the paper as dry as possible before it goes to the loft.

The lofts consist of a number of spaces filled with *tribbles*, that is, hair-ropes fixed into spars of wood, the ends of which are made to slide up and down the upright posts of wood, one of which is fixed at the corner of each space. The paper is hung up in *spurs*, as they are called, of five or six sheets thick, upon the ropes, by the help of a wooden cross, shaped somewhat like the letter T. The workman holds this cross at the lower part of it, and the top of the cross must be as long as the width of the sheet. The dryworker then, with his left fore-finger and thumb, pinches the corner of the hard-pressed *pack*, which has undergone one, two, or, if fine writing paper, three, hard-pressings since it left the felts. He then partially raises by that corner the spur of five or six sheets, and with the cross gently catches the paper, which he slips over the hair-line, and leaves it there suspended. The pack is placed on a table which moves on small wheels, and against which the workman stands, and which he can push or draw with ease to any part of the loft that he pleases. When the tribble lines are all full, he pushes up the sides or spars upwards along the upright posts, which are bored all the way up for small pins of wood that support the tribbles; about eight or nine tribbles fill a *room*, as it is called, that is, each space. The sides of the lofts are boarded with spars of wood, placed vertically, about four inches wide and four separate. Inside of these are shutters made exactly similar, but fixed on wheels which move in a groove, so as to shut in the loft entirely or partially, or leave it open, according to the state of the weather. Many lofts have, in addition, woollen curtains within the shutters, which, with the addition of the heat derived from steam carried round the loft in pipes, are most serviceable for drying when the state of the weather renders it impracticable to dry by the air.

When the weather is favourable, the paper, before being sized, may be dried in twenty-four hours. After being sized, it ought not to be dried in less than three or four days, as by too rapid drying the size has a great tendency to fly from the paper; and therefore, when hung up after undergoing this process, the shutters are, in general, immediately closed upon it, so as to make the drying as gradual as possible.

Messrs Cowan's drying lofts at Valleyfield Mills, near Edinburgh, are perhaps as extensive as any in the kingdom. The paper is brought up to the loft by a crane on a scale, which is then in the loft placed on a carriage upon wheels, that moves on a railway along the centre of the lofts, forming a continuous line of about 360 feet in length. There are about 60 rooms or spaces, with nine tribbles in each, making about 500 tribbles in all, which, when filled, hold about 1200 reams of post paper.

The paper up to this point is quite bibulous, and therefore unfit to bear the ink. It is therefore transferred, when dry, to the sizing-house. The size is made from the refuse of tan-yards, called *scrolls*, consisting of the parings of skins, pates, ears, &c.; which materials range in price, according to quality, from L.20 to L.40 per ton when thoroughly dried. The scrolls, as these pieces are called, are boiled for about ten hours, and the gelatine gradually and carefully strained off through straw, branches of trees, charcoal, &c., and lastly, through fine flannel bags. An addition of alum to the amount of about one fourth of the weight of the scrolls is then made. The size is run into chests or casks for use, where it soon congeals. When run off it is much too strong to size any description of paper with. When the sizing operation is to proceed, therefore, it is mixed up and diluted with water, in a small boiler, and heated with steam. From the boiler it is made to flow in a spout into a tub of about five feet square, which is also heated with steam introduced under a false bottom, it being very essential to use it always very hot. An additional quantity of alum is also made use of, which is placed in the spout, and is gradually dissolved as the size flows down in contact with it. The workman stands close to the tub, and dips the paper in handfuls, containing about six quires on an average, with a wrapper at top and bottom, which he soaks thoroughly, turning it backwards and forwards, so that every portion becomes completely penetrated with the size. It is also allowed to remain some minutes soaking in the tub, being held by wooden pincers suspended by a balance-weight. He then carefully lifts them out one by one, and places them in a press, adding to the heap till the press is full. The surplus size flows, and is then by a moderate pressure squeezed out of the paper, the edges of which are next rinsed by hot water, before the pressure is taken off, to prevent them from adhering together; and with the same view the heaps of paper, when taken out of the press, are enveloped with woollen cloths, so as to exclude the cold air.

Moreover, to prevent the paper from sticking when it is strongly sized, it is separated or parted sheet by sheet, after which it is pressed moderately, so as to make the *spurs* slightly adhere together. It is better to keep the sized paper forty-eight hours before hanging it up to dry, and then the more gradual the drying the better.

Another mode of sizing, which tends to save both labour and wrappers, is by means of a machine or wooden table about two feet from the floor, above which are placed two spars of wood parallel to each other, supported from the table. The spurs of paper are placed vertically on the table, that is, their long edge resting on the table and across it; and between each spur a thin slip of wood is introduced, which is attached to the spars of wood by means of hooks and eyes. The slips of wood are then pressed somewhat tightly together, so that the whole mass is easily raised, by a pulley fixed overhead, to a small carriage, by which the paper, when raised from the table, and thus suspended in the air, can be wheeled right over the tub, into which it is let down to receive the size. This tub is divided into two compartments by a wooden sole affixed to a screw, which lies horizontally, and is worked by some wheels, so as to press the paper. The paper, when let down into the other portion of the tub, has the frame and slips hooked away from it as soon as it is gently pressed by the screw, so as to keep it from falling down. The hot size is then allowed to flow in amongst the paper, on which, when thoroughly soaked with size, the screw is made to work, and to press it. A board which has been pressed down against the paper is now fastened to a board of similar construction by means of strong iron clamps, and the screw is worked back again, leaving the paper still under pressure. A strong false bottom of wood, on which the paper rests, is now raised by means of a rack and pinion, and with it the paper and the heavy planks confining it, above the liquid size; and whenever the pressure is removed, it is at once set aside as sized. The size left in the tub is then pumped back to the boiler to be again heated.

There cannot be a stronger evidence of the necessity for the stuff being well prepared, in order to obtain a sound paper, than the process of sizing. If the stuff has been slowly prepared by trituration, so as to hold a good deal of water, it will also hold and keep the size in a manner corresponding thereto; whereas a quickly prepared stuff, which has been cut rather than rubbed out, however strong the size that may be employed, can scarcely be got to keep it. It is also very injurious should any of the chlorine or chloride of lime be left in the paper unwashed out, as the glutinous matter is thereby decomposed, and rendered of no avail.

After the paper has again been thoroughly dried, it is taken to the *salle* or finishing-house, where it is pressed very often in order to take out the marks of the lines, and to improve the surface generally.[1] The hot-pressing is carried on by means of smooth paper boards which have been glazed by passing through metal rollers. The paper is placed alternately between these, and heat is communicated by hot iron plates being laid upon these at intervals of about six quires. These plates are heated in an iron box, into which a supply of steam is sent, and where they do not generally require to be more than five or ten minutes. These plates, by means of pressure, communicate a good deal of heat throughout the paper, after it has been all brought under the action of the hydraulic press.

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[1] A very laborious operation, and one injurious to the paper, used to be performed in the salle; that of picking out the knots and lumps in the paper by means of small knives. The paper could not fail to be injured by this system of scraping, and the ink was always apt to sink where it had been scraped; but this operation is now rendered almost unnecessary by the invention of the strainer, through which the pulp is strained before it passes into the vat.

In consequence, however, of the general use of steel pens, and perhaps to some extent of the fashion of the day, it is necessary to finish fine letter-papers now with a much higher gloss, and various methods have been adopted for this purpose. One of these methods consists in using, instead of the hot-pressing smooth glazed boards, copper plates made very smooth, on which the sheets of paper are laid, a copper plate and a sheet of paper alternately. These, when filled with about one quire of paper, are passed between a pair of iron rollers, where the pressure is equal to twenty or thirty tons, and which are driven by the machinery of the mill. By moving a clutch, a small wheel is thrown in and out of gear at pleasure, so that the workman can instantaneously reverse the motion of these rollers, and they can be made either to take the copper plates away, or to return them again towards him after they have passed through, so as to sustain the pressure twice over. Another workman attends on the other side of the rollers to return the copper plates. It requires three women to be attending to fill and empty each set of copper plates, one filling in the rough, another taking out the smooth paper, and the third lifting off the copper plates in succession, and placing them on the sheets of paper as these are laid down. When the paper has had three or four pressures, it is pretty smooth, and is then denominated *rolled* or *hot-pressed;* but if it be passed more frequently through the rollers, it acquires a higher surface, and is then called *glazed.* Each set of three women can in this manner fill in about twenty reams of paper in one day. The work is laborious, from the quickness with which it is done; and, from the sharp edges and corners of the copper plates, and of the paper itself, the women are very liable to have their fingers cut, so that this department of work is not very popular, and in some manufactories it has acquired the name of the *tread-mill.*

Another mode of giving a higher surface to paper is by passing it through a calender, or cylinders which have been made of cast iron, copper, or brass, or one of them, like the ordinary calenders, consisting of a paper bowl. But these, although they be accurately fitted and polished, are all more or less liable to receive marks or indentations from any minute hard substances, or from folds or creases which may be in the paper, and which they give out again, and thus mark the paper.

The paper is now, after being rolled or glazed, told out into quires or half quires, folded, and made up into reams, and is subjected to pressure under hydraulic presses in every stage. It is then tied up in a wrapper, with a label on it, for the protection of the duty, and, the label being filled up by the trader and officer respectively, the paper is weighed by the latter, and stamped, so as to denote the amount being charged against the maker. The trader is allowed to keep his uncharged paper in bond, so that he is so far more favourably situated than those who follow many exciseable trades, where the duty is levied on the raw material, or on the article in some process of manufacture. The regulations deemed necessary to protect the revenue are abundantly complicated and contradictory; but it must be allowed that, within the last few years, a disposition seems to have been manifested, both by the Board of Excise and their officers, to afford every facility, and cause as little annoyance as possible to the manufacturer; whilst the officers are now, generally speaking, a much more respectable and efficient class of men, than when their ranks used to be recruited from the decayed lacqueys and dissipated butlers of the gentry; and undeniably the appointment of Sir Henry Parnell's Commission of Excise Inquiry in 1833 has tended much to promote the comfort and freedom of the trader, and, at the same time, to afford additional security to the interests of the revenue.

Machine paper-making.

Hitherto we have considered this manufacture as carried on by the hand. The papers made in that way are, for the most part, fine writing papers, into which it is necessary to introduce the water-mark, showing the maker's name on the mould. As the machine cannot have a water-mark nor make any paper except upon a *wove* wire-cloth, all water-marked and laid paper is necessarily made by hand.

The stuff having come from the engine-house in pipes, and being contained in large circular chests or reservoirs ready for use, is in them kept constantly stirred by wooden agitators, so that it may not sink to the bottom, or flow out on the machine in thick and thin portions.

Fourdrinier's machine.

The machine which is now used so universally all over the kingdom is the invention of a Mr Louis Robert, and was brought to this country by M. Didot of Paris, who came over to England about thirty or forty years ago, and, with the assistance of the MM. Fourdrinier, and Mr Donkin the engineer, succeeded in perfecting the invention, and in acquiring a patent right, which was afterwards renewed for a longer period by parliament, in consequence of the patentee's not having derived sufficient compensation.

The stuff flows out of the chests CC, Plate CCCCIV. by a pipe *p*, on which there is a cock *b*, which the machine-man opens more or less wide, according to the thickness of the paper to be made. It falls into the spout *s*, where it meets a large supply of water, which has been in great part passed through the web of pulp before, as will be afterwards explained. It then falls into the vat at the opening of the spout, and is there agitated by the little hog, as it is called.

A very important improvement has, however, been introduced at this stage, which, though not part of MM. Fourdrinier's machine, is now universally applied to it. We allude to the straining of the stuff, and thereby keeping out of the paper all the knots and hard substances which it was formerly necessary to scrape out in the salle, to the great injury of the surface of the paper. The strainer is an American invention, and has been introduced into England for about nine years; and a patent is now enjoyed for it by the Messrs Ibotson of Poyle Mill, Buckinghamshire.

The strainer is generally used before the stuff flows into the vat. It consists of a brass rectangular trough of about five or six feet in length by two feet in width, with sides about four inches deep. The bottom consists of a number of heavy bars of brass, the surface of which is perfectly planed and polished. They are about one inch in breadth, and can be taken out at pleasure. When the strainer is at work, these bars, which rest on a projecting ledge, and which are very firmly fixed in by wedges, &c. are placed so as almost to be in contact along the whole of their well-fitted edges; and the spaces between them at the sides are occupied by thin wedges, of such a size as to correspond to the length of the fibres. The strainer is driven by means of a light iron or brass shaft which passes above it, and has two small notched wheels, one placed above each end, and working into the frame of the strainer. When the shaft revolves, therefore, it will be seen that at every notch the strainer is raised, and then quickly descends by its own weight, so as to produce a continual jerking motion, making about a hundred and thirty strokes per minute. The stuff is now flowing in, and the bars are placed so close to each other that the fibres must necessarily pass longitudinally. The knots, &c. are therefore kept back, and as they accumulate in the strainer, the workman, with a wooden rake, draws them towards himself, then shuts off the flow of the stuff in that direction by means of a kind of sluice, composed of a piece of wood, which is covered with felt, and which is pressed in across the strainer. The end of the strainer next the workman is therefore left dry, and with a thin piece of copper or other metal he scoops up the knots, &c. takes out the sluice, and repeats the operation when it is required.

After the stuff has been thus strained and mixed in the vat by the agitator working in it, it is allowed to flow out by a number of holes in the side of the vat. These holes are of an oval figure, about four inches long by two in width; and against each of them is accurately fitted a brass plate, attached to a rod. This rod is worked by a screw in the workman's hand, who can thereby again regulate the flow of the stuff into a little cavity or box at *c*. From this point a piece of leather or apron extends to the point *t*, from whence the stuff flows on an endless fine wire-cloth, on which the web is formed. This wire-cloth, which must be perfectly level, moves upon a number of small copper rollers, about an inch and a half diameter and an inch and a half separate. These rollers rest upon a frame, which is left so far free as to be moved laterally by a rod which is attached to a little crank *e*; and thus is produced a vibration, more or less quick, according to the nature of the stuff, which causes the water to flow through the wire-cloth, and connects the fibres of the pulp together. A large shallow wooden vessel is placed below the wire-cloth, called the save-all, which receives the water and the flour of the pulp in large quantity. The water then passes through a spout on the side of the machine, and flows into a box, from whence it is lifted up by the scoops *f*, and then meets the supply of stuff from the chest, and flows into the vat.

The edges of the paper are formed by pliable deckles, which were formerly made of leather, then of woollen cloth. Belts or deckles, however, composed of alternate layers of linen and caoutchouc, firmly cemented together, are now most generally employed. These belts are half an inch thick and about sixteen feet long, and are drawn by the pulley upon the shaft *g*. It will be seen that they move under a solid plate of iron or brass, which is moderately pressed down upon them, but not so much so as to impede their free motion along with the wire-cloth, whilst they fit sufficiently tight to it to prevent any of the stuff from flowing away laterally before the paper is set.

By the time these caoutchouc deckles leave the wire-cloth at the point *p* the stuff is no longer fluid, though a good deal of water still flows from it. The wire-cloth then passes on with the pulp upon it through the cylinders *ii*, of which the under one is of metal, covered with a jacket, as it is called, of felting or flannel; and the upper one is generally of wood, but hollow, and covered with mahogany about an inch and a half thick; that wood being less apt to shrink or get out of shape than any other; and this roller also has a jacket. A slight pressure is given by these, which are called the wet-press cylinders; and after this stage the paper pulp is led on upon an endless felt, which must proceed exactly at the same speed as the wire-cloth, as, by any irregularity in their motion, the pulp would break. The wire-cloth returns back round the under wet-press cylinders, to receive a new supply of pulp, and is supported by a series of copper tube rollers, which revolve by the friction of it. The wire-cloth is generally about twenty-five feet in length by five feet in width, and has about sixty holes in the lineal, or 3600 in the square inch.

The web of paper, still in a very wet state, is now carried away by an endless felt, between cast-iron cylinders *kk*, where it sustains a severe pressure, and where a great deal of water is squeezed out, after which the paper may be handled. It then passes through a second pair of press cylinders, that the mark of the felt which was impressed on the under surface by the first pressure may be removed; and for this purpose the under surface is now placed next the metal cylinder. The web then passes over the surface of a number of cylinders, heated with steam, and arranged as to number and relative position according to the ideas of the manufacturer or millwright. When the web has passed over about thirty lineal feet of surface heated in this manner, it is dry, and is wound upon a reel *l*.

When this reel has been filled, or has performed about a hundred and thirty revolutions, a spring, which holds in the ends of the reel, is taken out. The reel which is attached to the arms *m*, which move on the axis *n*, is moved quickly round, and changes places with the other reel, when the paper is torn through, and the end of the web is then attached to the reel in gear, which is filled, whilst the paper is being cut off the reel which is at liberty.

The paper machine moves at the rate of from twenty-five to forty feet per minute. The whole process, therefore, in its transition from liquid pulp at the one end, to dry paper at the other, occupies scarcely two minutes. This, in the ordinary state of the weather, could not formerly be done in less than seven or eight days. Supposing, therefore, that the machine makes ten yards lineal of a web per minute, or 600 in the hour; this is equal to a mile in three hours, or four miles per diem of twelve hours. The paper is generally made about fifty-four inches wide. Reckoning that there are 300 machines in Great Britain, and that they work twelve hours each day on an average (many go both day and night), the length of web would altogether be equal to 1200 miles, and the area of what was made would be about 3,000,000 yards daily.

Printing paper, which is now entirely made by the machine, is in general sized in the pulp. White soap, starch, glue, and dissolved rosin, are principally used for this purpose, with the addition of a few pounds of alum. Such of these as are used are put through a sieve into the beating engine. The web, before being dried off, is also in some mills passed through hot size, the surplus of which is pressed out between two cylinders. This tends to strengthen the paper materially; but it is not easy for paper to keep the size if it be dried off hastily on the cylinders; and this is difficult, if not impossible, in the finer descriptions of paper, where the material is not so strong as that for more common kinds, and not so favourable for being thoroughly sized.

The fine bluish tinge which so many writing papers possess is derived from a mineral but very expensive blue, namely, the oxide of cobalt, generally called smalts. This article used entirely to be imported from Saxony, Denmark, and Sweden; but the great improvements which have been effected by British manufacturers of late years have rendered it unnecessary to seek a supply abroad. In writing paper of fine quality it is usual to add four or five pounds of smalts to the hundredweight of rags.[1]

Cutting machines.

Several machines have of late years been invented for cutting paper as it is made by the machine. Amongst others, one by MM. Fourdrinier of Staffordshire has been very generally introduced and approved of. As it is capable, however, of cutting five or six thicknesses of paper at once, it is not in general attached to the machine, but in some contiguous convenient place. The paper is reeled on small rolls of about six inches diameter, and these are placed with the spindles lying in grooves in a curved frame, whence they are taken and passed round a drum, and then through some small rollers. After the web is divided longitudinally by circular knives, which are set opposite each other upon shafts on each side of the paper, the progress of it is stopped for an instant by a very ingenious contrivance, when a knife descends, beginning at one side of the web, which is held fast by a heavy weight laid across it, and cuts it across. The web then goes on till it has passed as much paper through as is the requisite size of the sheet, when the knife again descends. The sheets thus cut are carried on by a small felt moved in connection with the rest of the machinery.

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[1] This blue is now greatly cheaper than it was during the war, and even after its termination, having fallen from 2s. 6d. to 1s. 3d. per pound, which last is the present price for *FFFE* smalts.

The paper-machine is peculiarly suited for making thin papers, which are not easily made by hand without great damage in the couching department, from the difficulty of getting off the sheet whole upon the felt; namely, the thin paper for copying letters, tissue-papers used for putting before prints, &c. A large quantity of remarkably thin paper, also, made from old ropes of a better description than usual, and called pottery tissue, is made by MM. Fourdrinier and others, for printing the colours on the china, &c. which could never have been made by hand. The machine has also been of immense service in producing paper of large sizes of sheets for newspapers, which could not have been worked by hand. It would have been very serious and laborious work for a man to make paper even large enough for a single sheet of the Times newspaper, which measures two feet by three. Indeed, till about 1825, the legislature restricted the size of newspapers to twenty-two by thirty-two inches, beyond which they could not be stamped; which restriction was done away with just as soon as it became possible to make by machinery any size of paper that might be desired. But, perhaps, in no department of paper-making has the advantage of the machine shone so conspicuously as in the paper used for paper-staining, and the consequent great reduction in price of the hangings. Before the application of the machine, the paper used by paper-stainers was of the size of twenty-eight by twenty-three inches, called elephant. It required, in order to form a piece of twelve lineal yards, that sixteen or eighteen of these sheets should be pasted together, which is now rendered wholly unnecessary by the paper being furnished to the stainers in sheets of twelve yards each in length.

The chief seats of paper manufacture in Great Britain are,—

1. Kent, where it was first established, and where there are a great number of hand-mills for making fine water-marked writing papers. There are also a good many machines for fine writing and printing paper.

2. In Hertfordshire, Buckinghamshire, and Oxfordshire, the manufacture of fine printing papers is very extensively carried on, and all made by machinery.

3. In Lancashire and the contiguous counties, it is carried on to a very large extent, the material, as already noticed, being chiefly derived from the refuse of the cotton mills, to which is added a mixture of cotton-bagging, of which there is a large supply, and which tends to strengthen the paper. This description of paper, however, both from the impurities which are inseparable from so very dirty a material as the sweepings of the cotton mills, and from its spongy soft texture, is very inferior to that which is made out of a sound strong rag, provided that the trituration of the stuff, already adverted to, be done in a proper manner.

4. In Scotland the manufacture is carried on to a large and rapidly increasing extent. From the ready communication with London, and other causes, both fine writing papers and others find a ready market there. Independently of the white paper, there is manufactured in all parts of the country a large quantity of brown paper, made from old ropes, &c.

Mr M'Culloch, in his Commercial Dictionary, supposes that there are about 700 paper mills in England, and from seventy to eighty in Scotland. The former must, however, be on an average on a much smaller scale than the Scotch mills; for whilst the duty produced in England in 1833 amounted to L.622,933, it amounted in Scotland, in the same year, to L.102,536; thus showing, that although the mills in England are about ten times as numerous as those in Scotland, the duty is only about six times as much.

Paper is considerably adulterated with plaster of Paris, sometimes to the amount of thirty per cent., for the purpose of gaining weight. This can easily be detected by burning a portion of a sheet, when the plaster will remain after combustion in an ashy whitish-coloured residuum. Brown paper is also often mixed up with a good deal of ochre or clay, the makers saying that it is for the purpose of giving it a nice brown colour, though it may be doubted whether it be not also with the intention of increasing the weight.

The following table, showing the strength of different kinds of paper, has been prepared from actual experiment. It denotes the number of pounds avoirdupois required to break a strip of paper two inches wide, both ends being secured above, and the weights attached to a small wooden roller, resting upon the strip of paper.

	Weight in Grains avoirdupois, of a Superficial Foot.	Weight in Pounds, supported by a strip two Inches broad.
Bank post, very thin writing paper, sized	65	23
Ditto unsized, but thinner	48	13
Thick writing paper, machine made,	139	42
Ditto ditto, made by hand,	143	60
Ditto drawing paper, machine made,	217	55
Newspaper, sized at the machine	113	39
Paper used for Scotch bank-notes	95	70
Strong cartridge-paper	135	64
Pink blotting-paper	90	10

PAPER-MONEY—BANKS.

PART I.—PAPER-MONEY.

tility of aper- oney.

We endeavoured to explain, in the fifth section of the article Money, the reasons why paper has been used as a substitute for coins in the ordinary transactions of society, and the principles on which its value is maintained. It is consequently unnecessary to enter at length, on this occasion, on either of these subjects; but, to facilitate the understanding of what is to follow, we may shortly observe, that the employment of paper as a medium of exchange is an obvious means resorted to by society for saving expense and facilitating payments. An individual or an association, in whose wealth and discretion the public have confidence, issues promissory notes, binding himself or themselves to pay certain sums on demand, or at some specified period after the date of the notes. And it is obvious, that so long as these notes are punctually paid when due, and are not issued in excess, their circulation, besides being a source of profit to the issuers, is a great public accommodation. The weight of 1000 sovereigns exceeds twenty-one pounds troy, so that to pay or receive a large sum in metal would be exceedingly inconvenient; while there would be a great risk from loss, as well as a heavy expense incurred in the conveyance of specie from place to place. But with paper this may be effected with extreme facility, and payments of the largest sums, and at the greatest distances, may be made with almost no inconvenience or expense. And while the interest of individuals is thus consulted by the introduction and use of paper, it is of the greatest service to the public. Its employment, and the various devices for the economizing of currency to which it has led, enable the business of a commercial country like England to be carried on with a *tenth part*, perhaps, of the gold and silver currency that would otherwise be necessary. The cheapest instruments by which exchanges can be effected are substituted in the place of the dearest; and, besides doing their work better, this substitution enables the society to employ the various sums they must otherwise have employed as money, as capital in industrious undertakings, by which the public wealth and comforts are largely augmented. Of the various means, whether by the introduction of machinery or otherwise, that have been devised for promoting the progress of wealth and civilization, it would not be easy to point out one better calculated to attain its end than the introduction of a properly organized paper-money.

Definition of paper-money.

But paper-money, like many other highly useful inventions, is liable to great abuse, and, if not issued on sound principles, may become the cause of much mischief. By paper-money we mean notes issued by individuals or associations, for certain sums, and made payable on demand, or when presented. This description of paper is known in this country by the name of bank-paper, or bank-notes, from its being issued only by bankers. Bills of exchange, or bills issued by bankers, merchants, or other individuals, and payable some time after date, perform, also, in some respects, the functions of money; and being transferred from individuals, make payments much in the same way as if they consisted of bank-notes for the same amount.

Distinction between paper-money or bank-notes and bills of exchange.

But though there are many points in which a bill of exchange and a bank-note closely resemble each other, there are others in which there is a distinct and material difference between them. A note bears to be payable on demand; it is not indorsed by a holder on his paying it away; the party receiving has no claim on the party from whom he received it, in the event of the failure of the issuers;[1] and every one is thus encouraged, reckoning on the facility of passing it to another, to accept bank-paper, "*even though he should doubt the ultimate solvency of the issuers.*"[2] Bills, on the contrary, are almost all drawn payable at some distant period; and those into whose hands they come, if they be not in want of money, prefer retaining them in their possession, in order to get the interest that accrues upon them. But the principal distinction between notes and bills is, that every individual, in passing a bill to another, has to indorse it, and by doing so makes himself responsible for its payment. "A bill circulates," says Mr Thornton, "in consequence chiefly of the confidence placed by each receiver of it in the last indorser, his own correspondent in trade; whereas the circulation of a bank-note is owing rather to the circumstance of the name of the issuer being so well known as to give it an universal credit."[3] Nothing, then, can be more inaccurate than to represent bills and notes in the same point of view. If A pay to B L.100 in satisfaction of a debt, there is an end of the transaction; but if A pay to B a bill of exchange for L.100, the transaction is not completed; and, in the event of the bill not being paid by the person on whom it is drawn, B will have recourse upon A for its value. It is clear, therefore, that a great deal more consideration is always required, and may be fairly presumed to be given, before any one accepts a bill of exchange in payment, than before he accepts a bank-note. The note is payable on the instant, without deduction—the bill not until some future period; the note may be passed to another without incurring any risk or responsibility, whereas every fresh issuer of the bill makes himself responsible for its value. Notes form the currency of all classes, not only of those who are, but also of those who are not, engaged in business, as women, children, labourers, &c. who in most instances are without the power to refuse them, and without the means of forming any correct conclusion as to the solvency of the issuers. Bills, on the other hand, pass only, with very few exceptions, among persons engaged in business, who are fully aware of the risk they run in taking them. There is plainly, therefore, a wide and obvious distinction between the two species of currency; and it cannot be fairly argued, that because government interferes to regulate the issue of the one, it should also regulate the issue of the other.

When, therefore, we speak of notes, or paper-money, we mean notes issued by banks, and payable on demand. And unless when the contrary is mentioned, it is to these only that the subjoined statements apply.

Regulations with respect to the issue of notes.

To obviate the endless inconveniences that would arise from the circulation of coins of every weight and degree of purity, were there no restrictions on their issue, all governments have forbidden the circulation of coins not of a certain specified or standard weight and fineness. And the recurrence of similar inconveniences from the issue of notes for varying sums, and payable under varying conditions, have led, in all countries in which paper-money is made use of, to the enacting of regulations forbidding the issue of notes below a certain amount, and laying down rules for their payment. In England at this moment no note payable to bearer on demand can be issued for less than five pounds, and they must all be paid the moment they are presented. In Scotland and Ireland the minimum value of bank-notes is fixed at one pound, the regulations as to payment being the same as in England. In order to preserve the monopoly of the London circulation to the Bank of England, no notes payable to bearer on demand are allowed to be issued by individuals or associations, other than the Bank of England, within sixty-five miles of St Paul's. But beyond these limits every one who complies with the above regulations as to the minimum amount of notes, and who promises to pay them on demand, may, on paying the stamp-duty, and making returns of the issues to the stamp-office, circulate any amount of notes they can succeed in getting the public to take off.

Regulations as to the issue of notes defective.

We think it might be safely inferred, even if we wanted experience of the actual working of a currency so issued, that a system like this must unavoidably lead to the greatest abuse. The public is very apt to be deceived, in the first instance, in giving confidence to or taking the paper of an individual or an association; and though that were not the case, the condition of the individual or company may subsequently change from bad or expensive management, improvident speculation, unavoidable losses, and fifty other things of which the public can know nothing, or nothing certain. The fact that any particular banker who issues paper enjoys the public confidence, is, at best, a presumption merely, and no proof that he really deserves it. The public believes him to be rich and discreet; but this is mere hypothesis; the circumstances which excite confidence at the outset, and which preserve it, are often very deceptive; and in the vast majority of instances the public has no certain knowledge, nor the means of obtaining any, as to the real state of the case. But it is unnecessary to argue this point speculatively. There have, unfortunately, been innumerable instances in which it has turned out that bankers who had long been in the highest credit, and whose notes had been unhesitatingly accepted by the public, have been found to be, on the occurrence of any thing to excite suspicion, quite unable to meet their engagements.

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[1] Practically speaking, this is the fact; but a person paying away a bank-note is liable to be called upon for repayment should the bank fail before it was in the power of the party to whom it was paid, using ordinary diligence to present it. The responsibility seldom exceeds a couple of hours, and can hardly in any case exceed a couple of days. In practice it is never adverted to.

[2] Thornton on Paper Credit, p. 172.

[3] Ibid. p. 40.

The confining of the issue of notes to joint-stock associations would not give them additional security or value.

It has been supposed that the objections to the issue of notes on our present system, because of the risk of non-payment, might be obviated were they issued only by associations or joint-stock companies. But it is not easy to see on what principle leave should be granted to fifty or sixty individuals to do that which is to be denied to five or six. And though this difficulty were got over, the measure would not have the effect supposed. A single individual may possess more wealth than a number of individuals associated together; and the chances are, that if he engage in banking, or any other business, it will be better managed than by a company. Under our present system, and in fact it is impossible to prevent it under any system, the partners in joint stocks, as in other banks, may be men of straw, or persons without property, and unable to fulfil their engagements. It is of the essence of a secure and well-established paper currency, that the notes of which it consists should be of the exact value of the gold or silver they profess to represent, and that, consequently, they should be paid the moment they are presented. But it is not enough to order that this condition shall be uniformly complied with. Such order is obeyed only by the opulent, prudent, and conscientious banker, and forms little or no check on the proceedings of those of a contrary character. It is the latter class, however, that it is especially necessary to look after; and it is needless to say that any system that permits notes to be issued without let or hindrance by speculative, ignorant, or unprincipled adventurers, must be essentially vicious.

The issue of notes affords great temptation to, and facilities for, the commission of fraud.

The issue of notes is of all businesses that which seems to hold out the greatest prospect of success to the schemes of those who attempt to get rich by preying on the public. The cost of engraving and issuing notes is but an inconsiderable item compared with the sums for which they are issued; and provided they be got into any thing like extensive circulation, they become at once considerably productive. They are not issued, except, as explained in the article Money (sect. 5), on the deposit of bills or other securities, yielding a considerable rate of interest; so that if an individual, or set of individuals, with little or no capital, contrive, by fair appearances, promises, and similar devices, to insinuate himself or themselves into the public confidence, and can maintain L.20,000, L.50,000, or L.100,000 in circulation, he or they secure a good income in the mean time; and when the bubble bursts, and the imposture is detected, they are no worse off than when they set up their bank. On the contrary, the presumption is, that they are a great deal better off; and that they have taken care to provide, at the cost of the credulous and deceived public, a reserve stock for their future maintenance; hence, seeing the facilities for committing fraud are so very great, the propriety, or rather necessity, of providing against them.

Bank-paper substantially legal tender.

It has sometimes been contended, in vindication of our present system, that bank-notes are essentially private paper; that the accepting of them in payment is optional; and that as they may be rejected by every one who either suspects or dislikes them, there is no room or ground for interfering with their issue! But every body knows that, whatever notes may be in law, they are, in most parts of the country, practically and in fact, legal tender. The bulk of the people are totally without power to refuse them. The currency of many extensive districts consists in great part of country notes, and such small farmers or tradesmen as should decline taking them would be exposed to the greatest inconveniences. Every one makes use of, or is a dealer in, money. It is not employed by men of business only, but by persons living on fixed incomes, women, labourers, minors, and in short by every class of individuals, very many of whom are necessarily, from their situation in life, quite unable to form any estimate of the solidity of the different banks whose paper is in circulation. Such parties are uniformly severe sufferers by the failure of banks. The paper that comes into their hands is a part of the currency or money of the country, and it is quite as much a part of the duty of government to take measures that this paper shall be truly and substantially what it professes to be, as that it should take measures to prevent the issue of spurious coins, or the use of false or deficient weights and measures.

Security ought to be taken from the issuers of notes.

Now, it will be found, should the circulation of provincial notes be allowed to continue, that there is but one means of making sure of the solvency of the issuers, and of providing for their being paid when presented; and that is, by compelling all issuers of such notes to give security for their payment. This, and this only, will hinder the circulation of spurious paper, and afford a sufficient guarantee that the notes the public are obliged to take are really, and in fact, what they profess to be. The measure, too, is one that might be easily enforced. To carry it into effect, it would merely be necessary to order that all individuals or companies, on applying for stamps, should be obliged, previously to their obtaining them, to lodge in the hands of the commissioners an assignment to government stock, mortgages, landed or other fixed property, equivalent to the amount of the stamps issued to them, to be held in security for their payment.

It has been objected to this plan, that it would be injurious, by locking up a portion of the capital of the banks; but this is plainly an error. Its only effect in this respect would be to force such banks as issued notes to provide a supplemental capital, as a security over and above the capital required for conducting their business. But this supplemental capital would not be unproductive. If it consisted of lands, the owners would receive the rents; and if it consisted of government securities, they would receive the dividends or interest due upon them, precisely in the same way that they are received by other persons; while the fact being known that they possessed this supplemental capital, or that they had lodged security for the payment of their notes, would, by giving the public perfect confidence in their stability, enable them to conduct their business with a less supply of floating or immediately available capital than would otherwise be necessary.

It is absurd to object to this plan on the ground of its interfering with the private pursuits of individuals. It is the duty of government to interfere to regulate every business or pursuit that might otherwise become publicly injurious. On this principle it interferes to prevent the circulation of spurious coins, and of notes under a certain sum, and not payable on demand; and on the same principle it is called on to interfere to prevent the act ordering the payment of notes becoming again, as it has very frequently done already, a dead letter, by making sure that it shall be complied with. The interference that would take place under the proposed measure is not only highly expedient, but would be of the least vexatious kind imaginable. All that is required of the persons applying for stamps for notes is, that they should deposit in the hands of the commissioners a certain amount of exchequer bills, or other available securities, according to their demand for stamps. They are not asked to state how they mean to dispose of these stamps,—to whom or in what way they are to be issued. They are merely required to give a pledge that they shall be paid, or that they shall not be employed, as so many others have been, to deceive or defraud the public. It is little else than an abuse of language to call this an interference with private affairs.

The taking of security in the way now suggested, from the issuers of notes, would effectually provide for their payment when presented. Adventurers without capital, and sharpers anxious to get themselves indebted to the public, would find that banking was no longer a field on which they could advantageously enter. Notes would be made, in fact as well as in law, equivalent to the specie they profess to represent; and the paper currency would acquire a solidity of which it is at present wholly destitute.

The exacting of security from the issuers of paper would not obviate fluctuations in its amount and value, and would not, therefore, place the currency on a proper footing.

But though the plan of taking security would completely obviate the risk of loss from the circulation of worthless paper, or of paper issued by parties without the means, and probably also the inclination, to pay it on presentation, it would not touch another abuse inherent in the present system, that is, it would leave the currency exposed, as at present, to all those constantly recurring fluctuations in its amount—those alternations of glut and deficiency—by which it has been affected since provincial banks became considerably multiplied, and which are in the last degree injurious. A paper currency is not in a sound or wholesome state,—unless, 1*st*, means be taken to insure that each particular note or parcel of such currency be paid immediately on demand; and unless, 2*d*, *the whole currency vary in amount and value exactly as a metallic currency would do were the paper currency withdrawn and coins substituted in its stead.* The last condition is quite as indispensable to the existence of a well-established currency as the former; and it is one that cannot be realised otherwise than by confining the issue of paper to a single source.

All local issues of paper-money should be suppressed.

It is supposed by many, that there can be no greater fluctuations in a paper than in a metallic currency, provided the paper rest on an undoubted basis, and be regularly paid the moment it is presented. But this is an error. Wherever there are numerous issuers, there may be, and the chances are fifty to one there will be, perpetually recurring fluctuations in the amount and value of the currency. An over-issue of convertible paper is not, of course, indicated by any difference between the value of such paper and gold at home, but it is indicated by a fall of the exchange, and by an efflux of bullion to other countries. If paper were only issued by the Bank of England, or some one source in London, and then only in exchange for bullion, the currency would be in its most perfect state, and would fluctuate exactly as it would do were it wholly metallic. But at present it is quite otherwise. The currency is supplied by hundreds of individuals and associations, all actuated by different and frequently conflicting views and interests. The issues of the Bank of England, though not always, are generally governed by the state of the exchange, or rather by the influx and efflux of bullion, increasing when it flows into, and decreasing when it flows out of, the country. But it is quite otherwise with the provincial bankers. Their issues are not regulated by any such standard, but by the state of credit and prices in the districts in which they happen to be situated. If their managers suppose that these are good or improving, they rarely hesitate about making additional issues. Hence, when the state of the exchange, and the demand on the Bank of England for bullion, show that the currency is redundant, and ought to be contracted, the efforts of the Bank to effect its diminution are often impeded, and met by a contrary action on the part of the country banks. This is not owing to the ignorance of the latter. Under the supposed circumstances, the country bankers see, speaking generally, that they ought also to contract; but being a very numerous body, comprising several hundred establishments scattered over all parts of the country, each is impressed with the well-founded conviction, that all that he could do in the way of contraction would be next to imperceptible; and no one ever thinks of attempting it, so long as he feels satisfied of the stability of those with whom he deals. On the contrary, every banker knows, were he to withdraw a portion of his notes, that some of his competitors would most likely embrace the opportunity of filling up the vacuum so created; and that consequently he should lose a portion of his business, without in any degree lessening the amount of paper afloat. Hence, in nineteen out of twenty instances, the country banks go on increasing their aggregate issues long after the exchange has been notoriously against the country, and the Bank of England has been striving to pull up.

Issues of country bankers not dependent upon the exchange.

Efforts of the Bank of England to stop the efflux of bullion in 1836 counteracted by the country banks.

The circumstances now stated were strikingly exemplified in the course of 1836 and the early part of 1837. The excessive multiplication of joint-stock banks in 1836, the great additions they made to the number of notes afloat, and the still greater additions they made to the number of bills, checks, and other substitutes for money, occasioned a redundancy of the currency, a fall of the exchange, and a drain upon the Bank of England for gold. But while the latter was narrowing her issues, by supplying the exporters of bullion with gold in exchange for notes, the country banks went on increasing their issues! What the former did by contracting on the one hand, the latter more than undid by letting out on the other. The vacuum created by the withdrawal of Bank of England paper was immediately filled up, and made to overflow, by the issue of a more than equal amount of provincial paper; so that had it not been for the rise in the rate of interest, and the other repressive measures adopted by the Bank, the probability is, that she might have gone on paying away bullion for notes till she was drained of her last sixpence, without in any degree affecting the exchange. But this is not all. Not only do the country banks almost universally increase their issues when they ought to be diminished, but the moment they are compelled to set about their reduction, they run headlong into the opposite extreme, and unreasonable suspicion takes the place of blind unthinking confidence. The cry of *sauve qui peut* then becomes all but universal. It is seldom that a recoil takes place without destroying more or fewer of the provincial banks; and, provided the others succeed in securing themselves, little attention is usually paid to the interests of those they have taught to look to them for help. It may be worth while, in order to exhibit the truth of what has now been stated, shortly to advert to the destruction of country-bank paper in 1792–93, 1814, 1815, and 1816, 1825–26, and more recently in 1836–37.

Destruction of country banks and paper in 1792–93.

1. Previously to 1759 the Bank of England did not issue any notes for less than L.20; but having then commenced the issue of L.10 notes, her paper was gradually introduced into a wider circle, and the public became more habituated to its employment in their ordinary transactions. The distress and embarrassment that grew out of the American war proved exceedingly unfavourable to the formation of country banks, or of any establishments requiring unusual credit and confidence. No sooner, however, had peace been concluded, than everything assumed a new face. The agriculture, commerce, and still more the manufactures of the country, into which Watt and Arkwright's inventions had been lately introduced, immediately began to advance with a rapidity unknown at any former period. In consequence, that confidence which had either been destroyed or very much weakened by the disastrous events of the war was fully re-established. The extended transactions of the country required fresh facilities for carrying them on; and a bank was erected in every market-town, and almost in every village. The prudence, capital, and connections of those who set up these establishments

were but little attended to. The great object of a large class of traders was to obtain discounts; and the bankers of an inferior description were equally anxious to accommodate them. All sorts of paper were thus forced into circulation, and enjoyed nearly the same degree of esteem. The bankers, and those with whom they dealt, had the fullest confidence in each other. No one seemed to suspect that there was anything hollow or unsound in the system. Credit of every kind was strained to the utmost; and the available funds at the disposal of the bankers were reduced far below the level which the magnitude of their transactions required to render them secure.

The catastrophe which followed was such as might easily have been foreseen. The currency having become redundant, the exchanges took an unfavourable turn in the early part of 1792; a difficulty of obtaining pecuniary accommodation in London was not long after experienced; and notwithstanding the efforts of the Bank of England to mitigate the pressure, a violent revulsion took place in the latter part of 1792 and the beginning of 1793. The failure of one or two great houses excited a panic which proved fatal to many more. When this revulsion began, there were about three hundred and fifty country banks in England and Wales, of which about a hundred were compelled to stop payments, and upwards of fifty were totally destroyed, producing by their fall an extent of misery and bankruptcy till then unknown in England.

"In the general distress and dismay, every one looked upon his neighbour with caution, if not with suspicion. It was impossible to raise money upon the security of machinery, or shares of canals; for the value of such property seemed to be annihilated in the gloomy apprehension of the sinking state of the country, its commerce and manufactures; and those who had any money, not knowing where they could place it with safety, kept it unemployed and locked up in their coffers. Amid the general calamity, the country banks, which had multiplied greatly beyond the demand of the country for circulating paper currency, and whose *eagerness to push their notes into circulation* had laid the foundation of their own misfortunes, were among the greatest sufferers, and, consequently, among the greatest spreaders of ruin and distress among those connected with them; and they were also the chief cause of the drain of cash from the Bank of England, exceeding any demand of the kind for about ten years back. Of these banks above a hundred failed, whereof there were twelve in Yorkshire, seven in Northumberland, seven in Lincolnshire, six in Sussex, five in Lancashire, four in Northamptonshire, four in Somersetshire, &c."[1]

Attempts have sometimes been made to show that this crisis was not occasioned by an excess of paper-money having been forced into circulation, but by the agitation caused by the war then on the eve of breaking out. But there do not seem to be any good grounds for this opinion. The unerring symptoms of an overflow of paper—a fall of the exchange, and an efflux of bullion—took place early in 1792, or about twelve months before the breaking out of hostilities. Mr Chalmers states, that none of the great houses that failed during this crisis had sustained any damage from the war. The efforts of the country bankers to force their paper into circulation occasioned the redundancy of the currency, and it was on them, and on the country dealers and farmers dependent on them, that the storm principally fell.[2] It is of importance to remark, that the Bank of England had no notes for less than L.10 and the country banks for less than L.5 in circulation when the crisis of 1792–93 took place.

Destruction of country banks and paper in 1814, 1815, and 1816.

2. During the period from 1800 to 1813 the number of country banks had increased from about 400 to 922; and in consequence partly of this rapid increase, and partly of the suspension of cash payments at the Bank of England in 1797, and the issue of one-pound notes by that establishment and the country banks, the amount of paper afloat was vastly increased, particularly after 1808, when it sunk to a heavy discount as compared with bullion. Mr Wakefield, whose extensive employment in the management of estates in all parts of the country gave him the most favourable opportunities for acquiring correct information, stated to the agricultural committee of 1821, that "down to the year 1813 there were banks in almost all parts of England, forcing their paper into circulation at an enormous expense to themselves, and in most instances to their own ruin. There were bankers who gave commission, and who sent persons to the markets to take up the notes of other banks; these people were called money-changers, and commission was paid them." (Report, p. 213.) And among the various answers to the queries sent by the Board of Agriculture in 1816, to the most intelligent persons in different parts of the country, there is hardly one in which the excessive issue of country-bank paper is not particularly specified as one of the main causes of the unprecedented rise of rents and prices previously to 1814.

Influenced partly by this extraordinary increase of paper, and partly by deficient harvests and the exclusion of foreign supplies, the price of corn rose to an exorbitant height during the five years ending with 1813. But, owing partly to the luxuriant crop of that year, and partly and chiefly, perhaps, to the opening of the Dutch ports, and the renewed intercourse with the continent, prices sustained a very heavy fall in the latter part of 1813 and the beginning of 1814. And this fall, having produced a want of confidence and an alarm among the country bankers and their customers, occasioned such a destruction of country-bank paper as has not been paralleled except by the revulsion of 1825–26. In 1814, 1815, and 1816, no fewer than 240 country banks stopped payment, and eighty-nine commissions of bankruptcy were issued against these establishments, being at the rate of *one* commission against every *ten and a half* of the total number of banks licensed in 1813! This destruction of bank-paper is said to have produced an extent of wretchedness and misery never equalled in any European country by any similar catastrophe, except, perhaps, by the breaking up of the Mississippi scheme in France.

Destruction of country banks and paper in 1825–26.

3. The destruction of country paper during the period now referred to, by reducing the amount of the currency, raised its value in 1816 nearly to a par with the value of bullion, and enabled measures to be taken for reverting to cash payments at the Bank of England, which was effected by the act 59 Geo. III. cap. 78. But notwithstanding the ample experience that had been supplied by the occurrences of 1792–93 and 1814–16, of the mischievous consequences of the issue of paper by the country banks, and of their want of solidity, nothing whatever was done, when provision was made for returning to specie payments, to restrain their issues, or to place them on a better footing. The consequences of such improvidence were not long in manifesting themselves. The prices of corn and other agricultural products, which had been greatly depressed in consequence of abundant harvests, in 1820, 1821, and 1822, rallied in 1823; and the country bankers, true to their invariable practice on similar occasions, immediately began to enlarge their issues. It is unnecessary to inquire into the circumstances which conspired, along with the rise of prices, to promote the extraordinary rage for speculation exhibited in 1824 and 1825. It is sufficient

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[1] Macpherson's Annals of Commerce, vol. iv. p. 266.

[2] Comparative Estimate, p. 226, ed. 1812.

to observe, that in consequence of their operation, confidence was very soon carried to the greatest height. It did not seem to be supposed that any scheme could be hazardous, much less wild or extravagant. The infatuation was such, that even the most considerate persons did not scruple to embark in the most visionary and absurd projects; while the extreme facility with which discounts were procured upon bills at very long dates, afforded the means of carrying on every sort of undertaking. The most worthless paper was readily negotiated. Many of the country bankers seemed, indeed, to have no object other than to get themselves indebted to the public. And such was the vigour and success of their efforts to force their paper into circulation, that the amount of it afloat in 1825 is estimated to have been nearly fifty per cent. greater than in 1823.

The consequences of this extravagant and unprincipled conduct are well known. The currency having become redundant, the exchange began to decline in the summer of 1824. But the directors of the Bank of England having entered, in the early part of that year, into an engagement with the government to pay off such holders of four per cent. stock as might dissent from its conversion into a three and a half per cent. stock, were obliged to advance a considerable sum on this account after the depression of the exchange. This tended to counteract the effect of the drain on the Bank for gold, and in consequence the London currency was not very materially diminished till September 1825. This reduction was accompanied by a repetition of the events of 1793, but on a larger and more magnificent scale, and with more destructive consequences. The country banks began to give way the moment they experienced a considerably increased difficulty of obtaining accommodation in London, and all confidence and credit were immediately at an end. Suspicion having awakened from her trance, there were no limits to the run. Paper was not carried to the banks to obtain gold, in the view of exporting it, as a mercantile adventure, to the Continent, but for the purpose of escaping the loss which it became obvious a large portion of the holders of country notes would have to sustain. The destruction of country paper was so sudden and extensive, that in less than six weeks above seventy banking establishments were swept off, and a vacuum was created in the currency which absorbed from eight to ten millions of additional issues by the Bank of England; at the same time that myriads of those private bills that had previously swelled the amount of the currency, and added to the machinery of speculation, were wholly destroyed.

Measures for establishing joint-stock banks in 1826. Inadequacy of these measures.

4. Notwithstanding nations are proverbially slow and reluctant learners, the events of 1825–26, taken in connection with those of the same sort that had previously occurred, produced a conviction of the necessity of taking some steps to improve the system of country banking in England. But we regret to have to add, that the measures adopted in this view were very far indeed from being effectual to their object. In 1708 a law had been passed limiting the number of partners in banking establishments to six. This law was now repealed; and it was enacted that banks with any number of partners might be established for the issue of notes anywhere beyond sixty-five miles from London; and that banks not issuing notes might be established in London itself with any number of partners. The circulation of notes for less than five pounds in England and Wales was at the same time forbidden.

Much benefit was expected, but without any sufficient reason, to arise from these measures. So long as every one is allowed to issue notes without check or control, a thousand devices may be fallen upon to insure the circulation of those that are most worthless. Besides, there is no foundation whatever for the supposition, that the mere fact of a bank consisting of fifty or a hundred, instead of five or ten partners, renders it more worthy of confidence, or is any security that it will be better managed. The probability seems, in fact, to be rather the other way. A few wealthy individuals engaged in banking, or any other sort of business, must, if they would protect themselves from ruin, pay unremitting attention to their concerns, and act in a discreet and cautious manner. But the partners and managers of a great joint-stock company act under no such direct and pressing responsibility. The former, indeed, seldom take the trouble to inquire carefully into the business of the company; and the responsibility of their managers is of a very different kind from that of an opulent individual whose fortune is answerable for every error and false step he may commit. The recent history of the Northern and Central Joint-Stock Bank, and of various other associations, sufficiently establishes the truth of what has now been stated. The fact that there is a number of partners in a joint-stock bank, and the consequent notion, that though its affairs were to get into disorder, some of them would be able to make good the claims upon it, tends to procure a circulation for the notes of these establishments to which they may be very little entitled. They in truth afford very great facilities for the perpetrating of fraud both upon the partners and the public. And even when best managed, and resting on an impregnable foundation, they may and *do* issue in excess; and thus produce those fluctuations in the amount and value of the currency that are everywhere most disastrous, but especially in a commercial country.

The prohibition of the issue of one-pound notes has gone far to shut up one of the most convenient channels by which the inferior class of country bankers formerly contrived to get their notes into circulation; but there are many other channels still open to them, and of these they have not failed to avail themselves. We have already seen that there were no notes for less than five pounds in circulation in 1792–93, and yet fully a third part of the country banks then in existence stopped payments! This is enough to show how little security can be expected from this limitation.

Progress of the joint-stock system.

Those who supposed that joint-stock banks would be immediately set on foot in all parts of England, were a good deal disappointed with the slowness with which they spread for some years after the act permitting their establishment was passed. The heavy losses occasioned by the downfall of most of the joint-stock projects set on foot in 1824 and 1825, made all projects of the same kind be looked upon for a considerable period with suspicion, and deterred most persons from embarking in them. But this prejudice gradually wore off; and the increasing prosperity of the country, and the difficulty of vesting money so as to obtain from it a reasonable return, generated of new a disposition to adventure in hazardous projects. A mania for embarking in speculative schemes acquired considerable strength in 1835, and during the first six months of 1836 it raged with a violence but little inferior to that of 1825. It was at first principally directed to railroad projects; but it soon began to embrace all sorts of schemes, and, among others, joint-stock banks, of which an unprecedented number were projected in the course of the year. The progress of the system has been as follows:

	Banks.		Banks.
In 1826 there were registered	3	In 1832 there were registered	7
In 1827	4	In 1833	9
In 1828	0	In 1834	10
In 1829	7	In 1835	9
In 1830	1	In 1836	45
In 1831	9	Total	104

In point of fact, however, the number of banks created in 1836 was vastly greater than appears from this statement. We believe that, at an average, each of the forty-five banks established in that year, like those previously established, has from five to six branches; and as these branches transact all sorts of banking business, and enjoy the same credit as the parent establishment, from which they are frequently at a great distance, they are, to all intents and purposes, so many new banks; so that, instead of forty-five, it may safely be affirmed that about *two hundred* new joint-stock banks were opened in England and Wales in 1836, and mostly in the first six months of that year!

Over-issue by the joint-stock banks in 1836.

In January, February, and March 1836, when the rage for establishing joint-stock banks was at its height, the exchange was either at par, or but slightly in our favour, showing that the currency was already up to its level, and that if any considerable additions were made to it, the exchange would be depressed, and a drain for bullion be experienced. But these circumstances, if ever they occurred to the managers of the joint-stock banks, do not seem to have had, and could not in truth be expected to have, the least influence over their proceedings. Their issues, which amounted on the 26th of December 1835 to L.2,799,551, amounted on the 25th of June to L.3,588,064, exclusive of the vast mass of additional bills, checks, and other substitutes for money they had put into circulation. The consequences were such as every man of sense must have foreseen. In April 1836 the exchange became unfavourable, and bullion began to be demanded from the Bank of England. The latter, that she might the better meet the drain, raised the rate of interest in June from four to four and a half per cent., and this not being sufficient to lessen the pressure on her for discounts, she raised it in August from four and a half to five per cent. But during the whole of this period the country banks went on increasing their issues. We have already seen that, on the 25th of June 1836, their issues were L.788,513 greater than they had been on the preceding 26th of December; and notwithstanding the continued drain for bullion, and the rise in the rate of interest by the Bank of England in June and August, and the reduction of her issues, the issues of the joint-stock banks increased from L.3,588,064 in June, to no less than L.4,258,197 on the 31st of December, being an increase of nearly twenty per cent. after the exchange was notoriously against the country; and the most serious consequences were apprehended from the continued drain for bullion on the Bank of England!

It may perhaps be imagined that the increased issue of the joint-stock banks would be balanced by a corresponding diminution of the issues of the private banks, and that on the whole the amount of their joint issues might not be increased. This, however, was not the case. Some private banks were abandoned in 1836, and others incorporated with joint-stock banks; and it is farther true, that those which went on managed their affairs with more discretion than their associated competitors. But, from the 26th of September 1835 to the 31st of December 1836, the issues of the private banks were diminished only L.159,087, whilst those of the joint stocks were increased during the same period L.1,750,160, or more than *ten times* the falling off in the others!

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These statements show conclusively the extreme inexpediency of having more than one issuer of paper. Its issue ought in all cases to be governed exclusively by the state of the exchange, or rather, as already stated, by the influx and efflux of bullion. But the provincial banks may go on over-issuing for a lengthened period without being affected by a demand for bullion, or even for Bank of England paper. A drain for bullion always operates in the first instance on the Bank of England; and were she the sole issuer, she might always check the drain at the outset, by narrowing her issues, or by ceasing to replace the notes brought to her in exchange for bullion. But the country banks, not being immediately or speedily affected by the drain, take no steps to get rid of that redundancy of the currency by which it is occasioned; and, provided their credit be good, they may and *do* frequently go on for a lengthened period adding to their issues, and aggravating all the bad symptoms in the state of the currency. Thus we have seen the joint-stock banks in the early part of 1836 making large additions to their issues when the currency was already quite full; and, not stopping there, we have next seen them persisting, for more than six months, in increasing their issues in the teeth of a heavy and continued drain for bullion, a rapid rise in the rate of interest, and great apprehensions in the public mind. This conduct has nothing to do with the solidity of the banks. There is no reason whatever to think, supposing they had *all* given security for their issues, they would have been in any degree diminished. On the contrary, the probability is, that by putting an end to every doubt as to their stability, it would have materially facilitated their issues, and tempted them to increase them to a still greater extent.

But, in the end, an efflux of bullion is sure, by rendering money and all sorts of pecuniary accommodation scarce in the metropolis, to affect the country banks as well as the Bank of England; and then the shock given to industry, and the derangement of prices and transactions of all sorts, is severe in proportion to the previous over-issue. A revulsion of this sort seldom occurs without destroying some of the provincial banks, and exciting a panic, as was the case in 1792–93, and in 1825–26. But even when this is not the case, the check given to the practice of discounting, and the withdrawal of their accustomed accommodations from vast numbers of individuals, necessarily occasion a great deal of inconvenience and distress. The Bank of England, by bolstering up the Northern and Central Bank in November 1836, averted the bankruptcy of that establishment, which had no fewer than *forty* branches, and by doing so prevented the occurrence of a panic, and a run that would most likely have proved fatal to many other joint-stock and private banks. Still, however, the shock given to all sorts of industrious undertakings, by the revulsion in the latter part of 1836, although unaccompanied with any panic, was very severe. All sorts of commercial speculations were for a while completely paralysed, and there were but few districts in which great numbers of individuals were not thrown out of employment. In Paisley, Birmingham, and various other towns, the distress occasioned by the revulsion was very general and long-continued. The following memorial, subscribed by all the leading manufacturers, merchants, and traders of Birmingham, was presented to Lord Melbourne in March 1837. It sets the disastrous influence of fluctuations in the amount and value of the currency in a very striking light.

"My Lord,—We, the undersigned merchants, manufacturers, and other inhabitants of the town of Birmingham, beg leave respectfully to submit to your Lordship the following facts:—1. During the last two or three years a very great improvement has taken place in the trade and commerce of the town and neighbourhood. The workmen have generally been placed in a condition of full employment and good wages, producing a general state of satisfaction and contentment among them. Their employers also have enjoyed a condition of ease and security which might be called affluence when compared with the losses, difficulties, and anxieties which they endured for several years before. No stock of goods was accumulated, no overtrading of any kind existed; the products of one man's industry were readily exchanged for those of another; and all the products of industry in every trade were carried off into the absolute consumption of the people quite as fast as they could be produced.

"2. Suddenly within the last three months, with all the elements of general prosperity remaining unimpaired, this gratifying state of things has disappeared, and has been succeeded by a general state of difficulty and embarrassment, threatening the most alarming consequences to all classes of the community. Orders for goods are countermanded and discontinued, both for the foreign and home trade.

"The prices of goods are falling, so as in many cases to occasion a loss instead of a profit on their production. The process of production is thus obstructed; the workmen are beginning to be discharged, or to be placed upon short employment; and we are confident, that unless remedial measures be immediately applied, a large proportion of our population will shortly be thrown entirely out of employment.

"3. We earnestly solicit the serious and immediate attention of his majesty's government to this alarming state of things, confidently hoping that they will forthwith adopt decisive and effectual measures for its relief."

Certainly the legislature will most strangely neglect its duty, if it allow a system productive of such fatal consequences to continue to spread its roots and scatter its seeds on all sides. As long as any individual, or set of individuals, may usurp the royal prerogative, and issue money without let or hindrance, so long will it be issued in excess in periods when prices are rising and confidence high, and be suddenly and improperly withdrawn when prices are falling and confidence shaken. All the causes of fluctuation inherent in the nature of industry are aggravated a thousandfold by this vicious system, at the same time that it brings many new ones into existence. There is not, in fact, any reason for supposing, that if our currency had been either metallic, or made to fluctuate exactly as it would have done had it been metallic, that the difficulties in which we were involved in 1836 and 1837 would ever have been heard of. The inordinate increase of banks, of money, and of the facilities for obtaining money, in the spring of 1836, contributed powerfully to the rapid and uncalled-for increase of prices, the multiplication of wild and absurd projects, and the excess of confidence which distinguished that period; at the same time that, by bringing on a fall of the exchange and a drain for bullion, they insured the subsequent revulsion. If it be wished that the country should be kept for ever under an intermittent fever—now suffering from a hot and then from a cold fit, now in an unnatural state of excitement, leading to, and necessarily ending in, an unnatural state of depression—the present money system is the best possible. But we believe the reader will agree with us in thinking, that a fever of this sort is not more injurious to the animal than to the political body. So dangerous a disorder is not to be trifled or tampered with. This is not a case in which palliatives and anodynes can be of any real service. If a radical cure be not effected, it will go far to paralyse and destroy the patient.

Now, to accomplish this radical cure, that is, to make sure that *the fluctuations of the currency shall not exceed those which would occur were it wholly metallic*, it is indispensable, as already stated, that all local notes should be suppressed, and the issue of paper confined entirely to one body.

The exacting of security previously to the issue of notes would guarantee the holders from loss, and be in so far advantageous; but it would not hinder that competition among the issuers that is so very injurious, nor prevent the supply of paper being at one time in excess, and at another deficient. If we would provide for that unity of action and that equality of value that are so indispensable, we must make an end of a plurality of issuers. If one body only were intrusted with the issue of notes, it would be able immediately to narrow the currency when bullion began to be exported, and to expand it when it began to be imported; and it would be easy for the legislature to lay down and enforce such regulations as would effectually prevent the fluctuations in the amount and value of the currency ever exceeding those that would take place if it consisted wholly of the precious metals. But nothing of the sort need be attempted, so long as it is supplied by more than one source. Every thing must then be left to the discretion of the parties. And it will certainly happen in time to come, as it has invariably happened in time past, that some of them will be increasing their issues when they should be diminished, and diminishing them when they should be increased.

Mr S. J. Loyd, whose authority on all questions of this sort is so deservedly high, states distinctly, that "an adherence to sound principle would certainly lead to the conclusion, that the issues of paper-money should be confined to *one body, intrusted with full power and control over the issues, and made exclusively responsible for the due regulation of their amount*."[1] He is, however, disposed to think that the practice in this country, of individuals and associations issuing notes, has been so long established, and become so intimately connected with the habits and prejudices of the people, as to leave but little hope of its eradication. We do not, however, think that the difficulties in the way of the suppression of local notes would be found to be nearly so great were it set seriously about, as Mr Loyd seems to infer. Were parliament to enact that all local or provincial notes payable on demand in England and Wales should cease to circulate some two or three years hence, their withdrawal might, we apprehend, be effected with very little trouble and inconvenience. The circulation of notes, now that those for less than L.5 have been suppressed, is far from being one of the principal sources of banking profits. The stamp-duty, the expense of engraving, and the still heavier expense necessary to keep notes afloat, and to provide for their payment when they may happen to be presented, cut deep into the profits made by their issue. Our readers are no doubt generally aware that several country banks have, within the half dozen years ending with 1837, withdrawn their own notes from circulation, and issued in their stead those of the Bank of England, according to certain terms agreed on with the latter. The banks in question would not certainly have done this had it made any serious inroad on their profits. But it has not sensibly diminished them; and the proof of this is, that the banks which have made this arrangement realise quite as large profits as are realised by those that continue to issue notes of their own. We submit that this is decisive of the whole question. It proves that the profits of the provincial banks are not sensibly impaired by the substitution for their own, of Bank of England notes. Had the project for suppressing local notes been productive of any considerable loss to the issuers, it would have furnished a plausible, though by no means a valid, argument against it; for it would be contradictory and absurd to pretend that any set of persons can be entitled permanently to enjoy a privilege injurious to the community. But there is no room nor ground even for an appeal *ad mi-*

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[1] Reflections on the Pamphlet of Mr Horsley Palmer, p. 52.

sericordiam on the part of the private issuers. The fact that numbers of them have spontaneously, and without solicitation of any kind, abandoned the privilege of issue, and replaced their own notes with those of the central issuer in London, shows conclusively that the privilege in question is worth little or nothing, and, consequently, that it may be withdrawn without entailing any considerable hardship on any one. It is essential to the placing of the currency on a proper footing, that all local notes should be suppressed; and as their suppression would not be injurious to the issuers, what possible reason can be alleged for continuing their circulation?

Mode in which a single issuer of paper should act so as to make the amount and value of the currency vary exactly as if it were metallic.

We have said that it would be easy, were there only one issuer, to enforce compliance with such rules and regulations as would make the amount and value of the currency vary at all times exactly as if it were metallic. This has been doubted; but nothing could be more facile. Suppose that all local notes are withdrawn, and that there is only one issuer of paper; all that would be necessary to maintain an identity of amount and value between gold and paper would be, to regulate the currency exclusively by the influx and efflux of bullion; that is, never to issue an additional note except it be paid away for an equivalent amount of bullion brought to the office, nor to withdraw a note except when it is received in payment of an equivalent amount of bullion demanded from the office. The business of such an office would be entirely routine. Its managers would have no sort of discretion; their duty being merely to give paper for gold and gold for paper, according to the demands of the public. It has been frequently objected to the establishment of a national bank, that it would become a focus of intrigue and jobbing, and would be prostituted, or supposed to be prostituted, for the advancement of mere party purposes; and this, no doubt, would be the case were it allowed to discount and to transact ordinary banking business. A national bank for such purposes would be a national nuisance, that would very soon require to be abated. But were it confined, as it should be, to the mere issue of paper on the principle and in the way now stated, it could not be perverted to any sort of sinister object. Its conductors would be restricted to a sort of mill-horse path, and it would be impossible for them, even if so disposed, to show favour or partiality to any one. All would depend on an invariable rule; and the amount and value of the paper afloat would never exceed nor fall short of the amount and value of the bullion that would circulate in its stead were it withdrawn.

Supposing the average amount of paper afloat with a single issuer to be from thirty to forty millions, a stock of ten or twelve millions of bullion would be more than sufficient to begin with; for, it is hardly possible to imagine, under such a system, that any thing should ever occur to lessen the paper currency so much as twenty per cent., or consequently to occasion a demand for so much as six or eight millions of bullion.

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The Bank of England has endeavoured, for a considerable number of years past, to govern her issues nearly in the way now pointed out. But, in her present situation, having her operations frequently counteracted by other issuers, she neither can nor ought always to regulate her conduct by a regard to strict principle. She must look to the proceedings of others, by which she may be deeply compromised; and she must not only consider what may be the effect of the measures she may adopt on the exchange, or on the influx and efflux of bullion, but how they may be regarded by the provincial banks, and expected to influence them. Hence the Bank may frequently be justified in narrowing her issues when, had she been the sole issuer, she ought to have increased them, and conversely. But it is needless to say that this is a most unsatisfactory state of things, both as respects the Bank and the country. The former is obliged to exercise a discretion which cannot be safely confided to any set of individuals, whilst the latter is sure to suffer from all the errors into which the directors may fall, as well as from the disastrous consequences resulting from that competition of rival and conflicting issues, against which no degree of intelligence on the part of the directors of the Bank of England can possibly guard. In fact, we have no idea that it will be practicable for the latter and the country banks to go on together on their present footing. As matters now stand, the Bank of England may be brought at any time, and frequently is brought, into the greatest jeopardy by the proceedings of parties over whom she has no sort of control. The over-issue of the provincial banks, by depressing the exchange, drains the Bank of gold; and then their discredit, and perhaps failure, may, by exciting a panic, bring her to a stand still! Provided banks of deposit be established on sound principles, there cannot be too many of them. But it is quite otherwise with banks of issue. The more they are multiplied, the greater is the chance of fluctuation in their issues, and consequently in prices, credit, and so forth. Had the Bank of England been the sole issuer of paper, the crashes of 1792–93 and of 1825–26, and the revulsion of 1836–37, would not have occurred. They grew entirely out of the competition and proceedings of the provincial banks, and are in no degree whatever ascribable to anything else, domestic or foreign.

According to existing arrangements, the charter of the Bank of England must continue on its present footing till 1845. But we have no doubt, that were parliament to set about suppressing local issues,—an improvement that must precede every other,—the Bank would readily concur in any arrangement by which the proper regulation of her issues might be provided for and secured. But the suppression of local paper is indispensable as a preliminary to pave the way for other measures. Fluctuations in its amount and value are of the essence of a currency supplied by different issuers. If the country continue to tolerate the latter, it will unavoidably continue to suffer the perpetual recurrence of the former.

PART II.—BANKS.

Classes of banks.

Banks are commonly divided into banks of deposit and banks of issue; that is, banks that take care of other people's money, and banks that issue money of their own. But there are very few banks of issue that are not at the same time banks of deposit. This class of banks, as they exist in this and most other countries, are places where the money of individuals is received in deposit, payments being also made on their account, and loans made to the public. The managers of such banks are sometimes accustomed, as in most parts of England and Scotland, to pay interest at about one or two per cent. under the market rate for the money deposited in their hands; but when the business to be transacted in the receipt and payment of money on account of depositors is very large, it is not the practice for bankers, unless the deposits be proportionally great, to allow interest. The latter is the case in London. It is there customary for merchants and other people to send all the bills and drafts payable to them to their bankers, who make themselves responsible for their regular presentation for payment, and for their noting if not paid; and it is there also the practice to make all considerable payments by checks on bankers. Banking business is conducted in London at a heavy expense, and no little risk; and the

London bankers do not, therefore, except in special cases, allow interest on deposits. They are in the habit of stipulating, in order to indemnify themselves for their trouble and outlay, that the individuals dealing with them should keep an average balance of cash in their hands, varying according to the amount of business transacted on their account. The bankers then estimate, as well as they can, the amount of cash they must keep in their coffers to meet the probable demands of their customers, and employ the balance in discounting mercantile bills, in the purchase of government securities, or in some other sort of profitable adventure; so that their profits consist of the sum they realize upon such parts of the money lodged in their hands as they are able to employ in an advantageous way, after deducting the various expenses attendant on the management of their establishments. A bank of deposit would never be established if it had to depend on its own capital. It makes no profit, in its capacity of bank, till it begins to employ the capital of others.

Introduction and growth of private banking.

The business of banking was not introduced into London till the seventeenth century. It was at first conducted by the goldsmiths, who borrowed money from their customers at a certain rate of interest, and lent it to government and to private individuals at a higher rate. In the course of time, the business came to be conducted by houses who confined themselves to it only, and nearly in the mode in which we now find it. From 1708, as already stated, down to 1826, with the exception of the Bank of England, no company with more than six partners could be established, either in London or anywhere else in England and Wales, for conducting banking business; and by far the largest portion of that business is still conducted in the metropolis by firms with a small number of partners, or by what are called private banks.

Clearing house.

In 1775, the London, or rather the "city" bankers, established the "clearing house." This is a house to which each banker who deals with it is in the habit of daily sending a clerk, who carries with him the various bills and checks in the possession of his house that are drawn upon other bankers; and having exchanged them for the bills and checks in the possession of those others that are drawn upon his constituents, the balance on the one side or the other is paid in cash or Bank of England notes. By this contrivance the bankers connected with the clearing house are enabled to settle transactions to the extent of several millions a day, by the employment of not more, at an average, than from L.200,000 to L.500,000 cash, or Bank of England notes.

Regulations to which banks for deposit only should be subjected.

The security afforded by a bank of deposit is a matter as to which there must always be more or less of doubt. When, indeed, a banking company confines itself to its proper business, and does not embark in speculations of unusual hazard, or from which its funds cannot be easily withdrawn, in the event of any sudden run or demand, it can hardly ever fail of being in a situation to meet its engagements; whilst the large private fortunes that most commonly belong to the partners afford those who deal with it an additional guarantee. Much, however, depends on the character of the parties, and on a variety of circumstances with respect to which the public can never be correctly informed; so that though there can be no doubt that the security afforded by many private banks of deposit is of the most unexceptionable description, this may not be the case with others.

All joint-stock banks, or banks having more than six partners, whether for deposit and issue, or for deposit merely, are ordered, by the act 3 and 4 Will. IV. cap. 83, to send quarterly returns of the number and names of their partners to the stamp-office. We see no good reason why similar returns should not, and several why they should, be required from *all* banks; and provided means were adopted for the proper publication of such returns, so that everybody might know with whom they were dealing, but little if any farther information would be required with banks not issuing notes. There is in this respect a wide difference between them and banks of issue. It is the duty of the government to take care that the value of the currency shall be as invariable as possible; but it has never been pretended that it is any part whatever of its duty to inquire into the security given by the borrowers to the lenders of money, any more than into the security given by the borrowers to the lenders of any thing else. Government very properly obliges a goldsmith to have his goods stamped, this being a security to the public that they shall not be imposed on in buying articles of the quality of which they are generally ignorant; but it does not require that the persons to whom the goldsmith sells or lends his goods should give him a guarantee for their payment. This is a matter as to which individuals are fully competent to judge for themselves; and there neither is nor can be any reason why a lender or depositor of bullion or notes should be more protected than a lender or depositor of timber, coal, or sugar. Gold being the standard or measure of value, government is bound to take effectual precautions that the currency shall truly correspond in the whole and in all its parts with that standard,—that every pound note shall be worth a sovereign, and that the amount and value of the aggregate notes in circulation shall vary exactly as a gold currency would do were it substituted in their stead. But this is all that government is called upon to do. If A trust a sum of money in the hands of B, it is their affair, and concerns no one else. Provided the money afloat correspond with the standard, it is of no importance, in a public point of view, into whose hands it may come. The bankruptcy of a deposit bank, like that of a private gentleman who has borrowed largely, may be productive of much loss or inconvenience to its creditors. But if the paper in circulation be equivalent to gold, such bankruptcies cannot affect either the quantity or value of money; and are, therefore, injurious only to the parties concerned.

Establishment and history of the Bank of England.

The Bank of England, which has long been the principal bank of deposit and circulation, not in this country only, but in Europe, was founded in 1694. Its principal projector was Mr William Paterson, an enterprising and intelligent Scotch gentleman, who was afterwards engaged in the ill-fated colony at Darien. Government being at the time much distressed for want of money, partly from the defects and abuses in the system of taxation, and partly from the difficulty of borrowing, because of the supposed instability of the revolutionary establishment, the Bank grew out of a loan of L.1,200,000 for the public service. The subscribers, besides receiving eight per cent. on the sum advanced as interest, and L.4000 a year as the expense of management, in all L.100,000 a year, were incorporated into a society denominated the Governor and Company of the Bank of England. The charter is dated the 27th of July 1694. It declares, amongst other things, that they shall "be capable, in law, to purchase, enjoy, and retain to them and their successors, any monies, lands, rents, tenements, and possessions whatsoever; and to purchase and acquire all sorts of goods and chattels whatsoever, wherein they are not restrained by act of parliament; and also to grant, demise, and dispose of the same.

"That the management and government of the corporation be committed to the governor and twenty-four directors, who shall be elected between the 25th of March and the 25th day of April each year, from among the members of the company duly qualified.

"That no dividend shall at any time be made by the said governor and company, save only out of the interest, profit, or produce arising by or out of the said capital stock or fund, or by such dealing as is allowed by act of parliament.

"They must be natural-born subjects of England, or naturalized subjects; they shall have in their own name, and for their own use, severally, viz. the governor at least L.4000, the deputy-governor L.3000, and each director L.2000, of the capital stock of the said corporation.

"That thirteen or more of the said governors and directors (of which the governor or deputy-governor must be always one) shall constitute a court of directors, for the management of the affairs of the company, and for the appointment of all agents and servants which may be necessary, paying them such salaries as they may consider reasonable.

"Every elector must have, in his own name and for his own use, L.500 or more capital stock, and can only give one vote. He must, if required by any member present, take the oath of stock, or the declaration of stock in case he be one of the people called Quakers.

"Four general courts to be held in every year, in the months of September, December, April, and July. A general court may be summoned at any time, upon the requisition of nine proprietors duly qualified as electors.

"The majority of electors in general courts have the power to make and constitute by-laws and ordinances for the government of the corporation, provided that such by-laws and ordinances be not repugnant to the laws of the kingdom, and be confirmed and approved, according to the statutes in such case made and provided."

The corporation is prohibited from engaging in any sort of commercial undertaking other than dealing in bills of exchange, and in gold and silver. It is authorized to advance money upon the security of goods or merchandise pledged to it; and to sell by public auction such goods as are not redeemed within a specified time.

It was also enacted, in the same year in which the Bank was established, by statute 6 William and Mary, c. 20, that the Bank, "shall not deal in any goods, wares, or merchandise (except bullion), or purchase any lands or revenues belonging to the crown, or advance or lend to their majesties, their heirs or successors, any sum or sums of money, by way of loan or anticipation, or any part or parts, branch or branches, fund or funds, of the revenue, now granted or belonging, or hereafter to be granted, to their majesties, their heirs and successors, other than such fund or funds, part or parts, branch or branches, of the said revenue only, on which a credit of loan is or shall be granted by parliament." And in 1697 it was enacted, that the "common capital or principal stock, and also the real fund, of the governor and company, or any profit or produce to be made thereof, or arising thereby, shall be exempted from any rates, taxes, assessments, or impositions whatsoever, during the continuance of the Bank; that all the profit, benefit, and advantage from time to time arising out of the management of the said corporation, shall be applied to the uses of all the members of the said association of the governor and company of the Bank of England, rateably and in proportion to each member's part, share, and interest in the common capital and principal stock of the said governor and company hereby established."

In 1696, during the great recoinage, the Bank was involved in great difficulties, and was even compelled to suspend payment of her notes, which were at a heavy discount. Owing, however, to the judicious conduct of the directors, and the assistance of the government, the Bank got over the crisis. But it was at the same time judged expedient, in order to place her in a situation the better to withstand any adverse circumstances that might afterwards occur, to increase her capital from L.1,200,000 to L.2,201,171. In 1708, the directors undertook to pay off and cancel one million and a half of exchequer bills they had circulating two years before, at four and a half per cent., with the interest upon them, amounting in all to L.1,775,028, which increased the permanent debt due by the public to the Bank, including L.400,000 then advanced in consideration of the renewal of the charter, to L.3,375,028, for which they were allowed six per cent. The bank capital was then also doubled, or increased to L.4,402,343. But the year 1708 is chiefly memorable, in the history of the Bank, for the act previously alluded to, which declared, that during the continuance of the corporation of the Bank of England, "it should not be lawful for any body politic, erected or to be erected, other than the said governor and company of the Bank of England, or of any other persons whatsoever, united or to be united in covenants or partnership, exceeding the number of six persons, in that part of Great Britain called England, to borrow, owe, or take up any sum or sums of money on their bills or notes payable on demand, or in any less time than six months from the borrowing thereof." This proviso, which has had so powerful an operation on banking in England, is said to have been elicited by the Mine-Adventure Company having commenced banking business, and begun to issue notes.

The charter of the Bank of England, when first granted, was to continue for eleven years certain, or till a year's notice after the 1st of August 1705. The charter was further prolonged in 1697. In 1708, the Bank having advanced L.400,000 for the public service, without interest, the exclusive privileges of the corporation were prolonged till 1733. And in consequence of various advances made at different times, the exclusive privileges of the Bank have been continued by successive renewals, till a year's notice after the 1st of August 1855, under the proviso that they may be cancelled on a year's notice to that effect being given on the 1st of August 1845.

Renewals of Bank charter, with the conditions.

We subjoin an account of the successive renewals of the charter, of the conditions under which these renewals were made, and of the variations in the amount and interest of the permanent debt due by government to the Bank, exclusive of the dead weight.

Date of Renewal.	Conditions under which Renewals were made, and Permanent Debt contracted.	Permanent Debt.		
		L.	s.	d.
1694	Charter granted under the act 5 and 6 Will. III. c. 20, redeemable upon the expiration of twelve months' notice after the 1st August 1705, upon payment by the public to the Bank, of the demand therein specified. Under this act the Bank advanced to the public L.1,200,000 in consideration of their receiving an annuity of L.100,000 a year, viz. eight per cent. interest, and L.4000 for management..............................	1,200,000	0	0
1697	Charter continued by 8 and 9 Will. III. c. 20, till twelve months' notice after 1st of August 1710, on payment, &c. Under this act the Bank took up and added to their stock L.1,001,171 exchequer bills and tallies.			
1708	Charter continued by 7 Anne, c. 7, till twelve months' notice after 1st of August 1732, on payment, &c. Under this act the Bank advanced L.400,000 to government without interest; and delivered up to be cancelled L.1,775,027. 17s. 10d. exche-			

Date of Renewal.	Conditions under which Renewals were made, and Permanent Debt contracted.	Permanent Debt. L.	s.	d.
	Brought forward,	1,200,000	0	0
	quer bills, in consideration of their receiving an annuity of L.106,501. 13s. being at the rate of six per cent.........	2,175,027	17	10
1713	Charter continued by 12 Anne, stat. 1, cap. 11, till twelve months' notice after the 1st of August 1742, on payment, &c.			
	In 1716, by the 3d Geo. I. c. 8, the Bank advanced to government, at five per cent.......	2,000,000	0	0
	And by the same act, the interest on the exchequer bills cancelled in 1780 was reduced from six to five per cent.			
	In 1721, by 8 Geo. I. c. 21, the South Sea Company were authorized to sell L.200,000 government annuities, and corporations purchasing the same at 26 years' purchase were authorized to add the amount to their capital stock. The Bank purchased the whole of these annuities at 20 years' purchase........	4,000,000	0	0
	Five per cent. interest was payable on this sum to midsummer 1727, and thereafter four per cent.	9,375,027	17	10
	At different times between 1727 and 1738, both inclusive, the Bank received from the public, on account of permanent debt, L.3,275,027. 17s. 10d. and advanced to it on account of ditto L.3,000,000: Difference	275,027	17	10
	Debt due by the public in 1738..................................	9,100,000	0	0
1742	Charter continued by 15 Geo. II. c. 13, till twelve months' notice after the 1st of August 1764, on payment, &c.			
	Under this act the Bank advanced L.1,600,000 without interest, which being added to the original advance of L.1,200,000, and the L.400,000 advanced in 1710, bearing interest at six per cent., reduced the interest on the whole to three per cent......	1,600,000	0	0
	In 1745, under authority of 19 Geo. II. c. 6, the Bank delivered up to be cancelled L.986,000 of exchequer bills, in consideration of an annuity of L.39,472, being at the rate of three per cent.................	986,000	0	0
	In 1749, the 23d Geo. II. c. 6, reduced the interest on the four per cent. annuities, held by the Bank, to three and a half per cent. for seven years from the 25th of December 1750, and thereafter to three per cent.			
1764	Charter continued by 4 Geo. III. c. 25, till twelve months' notice fter the 1st of August 1786, on payment, &c.			
	Under this act the Bank paid into the exchequer L.110,000, free of all charge.			
1781	Charter continued by 21 Geo. III. c. 60, till twelve months' notice after the 1st of August 1812, on payment, &c.			
	Under this act the Bank advanced L.3,000,000 for the public service for three years, at three per cent.			
	Carry forward.........	11,686,000	0	0
	Brought forward,	11,686,000	0	0
1800	Charter continued by 40 Geo. III. c. 28, till twelve months' notice after the 1st of August 1833, on payment, &c.			
	Under this act the Bank advanced to government L.3,000,000 for six years without interest; but in pursuance of the recommendation of the committee of 1807, the advance was continued, without interest, till six months after the signature of a definitive treaty of peace.			
	In 1816, the Bank, under authority of the act 56 Geo. III. c. 96, advanced at three per cent., to be repaid on or before the 1st of August 1833..........	3,000,000	0	0
1833	Charter continued by 3 and 4 Will. IV. c. 98, till twelve months' notice after the 1st of August 1855, with a proviso that it may be dissolved on twelve months' notice after the 1st of August 1845, on payment, &c.	14,686,000	0	0
	This act directs that in future the Bank shall deduct L.120,000 a year from their charge on account of the management of the public debt; and that a fourth part of the debt due by the public to the Bank, or L.3,638,250, be paid off..................................	3,638,250	0	0
	Permanent advance by the Bank to the public, bearing interest at three per cent., independent of the advances on account of dead weight, or other public securities held by her...	11,047,750	0	0

For further details as to this subject, see the appendix, No. 1, of the Report of 1832 on the Renewal of the Bank Charter, and the acts of parliament referred to in it. See also James Postlethwayt's History of the Revenue, pp. 301–310; and Fairman on the Funds, seventh edition, pp. 85–88, &c.

The capital of the Bank on which dividends are paid has never exactly coincided with, though it has seldom differed very materially from, the permanent advance by the Bank to the public. We have already seen that it amounted in 1708 to L.4,402,243. Between that year and 1727 it had increased to near L.9,000,000. In 1746 it amounted to L.10,780,000. From this period it underwent no change till 1782, when it was increased eight per cent., or to L.11,642,400. It continued stationary at this sum down to 1816, when it was raised to L.14,553,000, by an addition of twenty-five per cent. from the profits of the Bank, under the provisions of the act 56 Geo. III. c. 96. The act for the renewal of the charter 34 Will. IV. c. 98, directed that the sum of L.3,638,250, the portion of debt due to the Bank to be repaid by the public, should be deducted from the Bank's capital; which, in consequence, is now L.10,914,750. (*Report on Bank Charter*, Appen. No. 33.)

Runs upon the Bank.

The Bank of England has been frequently affected by panics amongst the holders of her notes. In 1745 the alarm occasioned by the advance of the Highlanders, under the Pretender, as far as Derby, led to a run upon the Bank; and in order to gain time to effect measures for averting the run, the directors adopted the device of paying in shillings and sixpences! But they derived a more effectual relief from the retreat of the Highlanders, and from a resolution agreed to at a meeting of the principal merchants and traders of the city, and very numerously signed, declaring the willingness of the subscribers to receive bank-notes in payment of any sum that might be due to them, and pledging themselves to use their utmost endeavours to make all their payments in the same medium.

During the tremendous riots in June 1780 the Bank incurred considerable danger. Had the mob attacked the establishment at the commencement of the riots, the consequences might have proved fatal. Luckily, however, they delayed their attack till time had been afforded for providing a force sufficient to insure its safety. Since that period a considerable military force is nightly placed in the interior of the Bank, as a protection in any emergency that may occur.

spension cash- yments 1797.

The year 1797 is the most important epoch in the recent history of the Bank. Owing partly to events connected with the war in which we were then engaged; to loans to the Emperor of Germany; to bills drawn on the treasury at home by the British agents abroad; and partly, and chiefly, perhaps, to the advances most unwillingly made by the Bank to government, which prevented the directors from having a sufficient control over their issues, the exchanges became unfavourable in 1795, and in that and the following year large sums of specie were drawn from the Bank. In the latter end of 1796 and beginning of 1797, considerable apprehensions were entertained of invasion, and rumours were propagated of descents having been actually made on the coast. In consequence of the fears that were thus excited, runs were made on the provincial banks in different parts of the country; and some of them having failed, the panic became general, and extended itself to London. Demands for cash poured in upon the Bank from all quarters; and, on Saturday the 25th of February 1797, she had only L.1,272,000 of cash and bullion in her coffers, with every prospect of a violent run taking place on the following Monday. In this emergency, an order in council was issued on Sunday the 26th, prohibiting the directors from paying their notes in cash until the sense of parliament should be taken on the subject. And after parliament met, and the measure had been much discussed, it was agreed to continue the restriction till six months after the signature of a definitive treaty of peace.

As soon as the order in council prohibiting payments in cash appeared, a meeting of the principal bankers, merchants, traders, &c. of the metropolis, was held at the Mansion-house when a resolution was agreed to, and very numerously signed, pledging, as had been done in 1745, those present to accept, and to use every means in their power to cause bank-notes to be accepted, as cash in all transactions. This resolution tended to allay the apprehensions that the restriction had excited.

Parliament being sitting at the time, a committee was immediately appointed to examine into the affairs of the Bank; and their report put to rest whatever doubts might have been entertained with respect to the solvency of the establishment, by showing, that at the moment when the order in council apeared, the Bank was possessed of property to the amount of L.15,513,690, after all claims upon her had been deducted.

Much difference of opinion has existed with respect to the policy of the restriction in 1797; but, considering the peculiar circumstances under which it took place, its expediency seems abundantly obvious. The run did not originate in any over-issue of bank-paper, but grew entirely out of political causes. As long as the alarms of invasion continued, it was clear that no bank-paper immediately convertible into gold would remain in circulation. And as the Bank, although possessed of ample funds, was without the means of instantly retiring her notes, she might, but for the interference of government, have been obliged to stop payment; an event which, had it occurred, must have produced consequences in the last degree fatal to the public interests.

Resumption of cash-payments in 1821.

The error of the government did not consist in their coming to the assistance of the Bank, but in their continuing the restriction after the alarm of invasion had ceased, and there was nothing to hinder the Bank from safely reverting to specie payments. We have already pointed out (see article Money, vol. xv. p. 402) the influence of the suspension upon the conduct of the Bank, and the depreciation to which it led. But the destruction of country-bank paper in 1814, 1815, and 1816, having, by reducing the amount of currency, raised its value nearly to a level with that of gold, the legislature was able to revert with comparatively little difficulty to the old standard. The act for this purpose, 59 Geo. III. cap. 78, has been commonly called Peel's bill, from its having been introduced and carried through parliament by Mr (now Sir Robert) Peel. To facilitate the return to specie payments, the Bank was authorized, in the first instance, to pay in bars of standard bullion. She, however, recommenced payments in coin in May 1821, and has since continued them without interruption.

Bank-notes made legal tender everywhere except at the Bank.

Having already given some account of the derangements of the currency in 1825–26, and in 1836–37, it is needless again to allude to them here. When the charter was renewed in 1833, the notes of the Bank of England were made legal tender everywhere except at the Bank. Of the wisdom of this regulation no doubt can be entertained. Bank-notes are necessarily always equivalent to bullion; and by making them substitutes for coin at country banks, the demand for the latter during periods of alarm or runs is materially diminished, and the stability of the Bank and of the pecuniary system of the country proportionally increased. Since 1826 the Bank has established branches in some of the great commercial towns.

Principle on which the Bank endeavours to regulate her conduct.

The principle which the Bank endeavours to keep in view in conducting her business is, that she should so manage her affairs as to have always on hand a stock of coin and bullion equal to a third part of her liabilities; that is, to a third part of the gross amount of her issues and deposits. But in practice she is obliged frequently to depart from this rule; and we have already seen that the circumstances under which the Bank is placed, in consequence of there being hundreds of rival issuers, are such as to make it impossible for her to abide constantly by any system in the regulation of her issues, or to act in the way that it would be for her interest as well as her duty to act were she the sole issuer of paper.

Bank of England in connection with the government.

The Bank of England transacts the whole business of government. "She acts not only," says Dr Smith, "as an ordinary bank, but as a great engine of state. She receives and pays the greater part of the annuities which are due to the creditors of the public; she circulates exchequer bills; and she advances to the government the annual amount of the land and malt taxes, which are frequently not paid till some years thereafter." Previously to 1834 the Bank received about L.270,000 a year from the public for her trouble in managing the national debt, paying dividends, transferring stock, &c. But the act renewing the charter having directed that L.120,000 should be deducted from this charge, it now amounts to about L.150,000 a year.

Assistance rendered by Bank to the mercantile interest.

The greater part of the paper of the Bank has generally been issued in the way of advances or loans to government, upon security of certain branches of the revenue, and in the purchase of exchequer bills and other government securities, and bullion. But her issues through the medium of discounts and loans to individuals have notwithstanding been at all times considerable, while during periods of distress they are often very large. Generally speaking, however, the directors do not think it advisable to enter into competition with private bankers in the transacting of ordinary banking business, or in the discounting of ordinary mercantile paper; and for this reason the interest charged by them is usually one or one and a half per cent. higher than that charged by private bankers and dealers in discounts. When, however, any circumstances occur to occasion a pressure in the money market, the market rate of interest immediately rises to the rate fixed by the Bank, and on such occasions the private bankers and the public generally resort to her for aid. She then becomes as it were a *point d'appui*—a bank of support—and has frequently rendered in that capacity essential service, as in the famous instances of 1792–93, 1815–16, 1825–26, and 1836–37. The interference of the Bank on the latter occasion, in propping up the Northern and Central Bank, though in some respects objectionable, and in supporting the American houses till they got their engagements greatly reduced, no doubt averted a severe pecuniary crisis.

The Bank of England allows no interest, either at the head office in London, or at the branches, for deposits. She is, we believe, influenced in this respect by an apprehension, that were she to allow interest, she might be encumbered with too great an accumulation of deposits, which it might be difficult to employ advantageously, and which, in a period of alarm, might endanger her security. It is not to be denied that there is great weight in these considerations.

The dividends on bank stock, from 1767 to the present time, have been:—From 1767 to 1781, five and a half per cent. per annum; from 1781 to 1788, six per cent.; from 1788 to 1807, seven per cent.; from 1807 to 1823, ten per cent.; and from 1823 to the present time (1838) eight per cent. The sums paid as dividends are exclusive of those which have occasionally been advanced as bonuses: the latter amount, since 1799, to L.3,783,780, over and above the increase of the Bank's capital in 1816, which amounted to L.2,910,600.

TABLES EXHIBITING THE CONDITION OF THE AFFAIRS OF THE BANK OF ENGLAND.

I.—*State of the Affairs of the Bank of England, 29th of February* 1832.

Dr.	L.	L.
To bank-notes outstanding.......	....	18,051,710
To public deposits, viz.		
Drawing accounts................	2,034,790	3,198,730
Balance of audit roll............	550,550	
Life annuities unpaid...........	85,030	
Annuities for terms of years unpaid...........................	38,360	
Exchequer bills deposited.....	490,000	
To private deposits, viz.		
Drawing accounts................	5,683,870	5,738,430
Various other debts.............	54,560	
To the Bank of England for the capital..............................	....	14,553,000
To balance of surplus in favour of the Bank of England........	....	2,637,760
		L.44,179,630

Cr.	L.	L.
By advances on government securities; by exchequer bills on the growing produce of the consolidated fund in the quarter ending 5th of April 1832...	3,428,340	4,134,940
Ditto 5th of July 1832..............	697,000	
Exchequer bills on supplies 1825	7,600	
Ditto for L.10,500,000 for 1825..	2,000	
By the advances to the trustees appointed by the act 3 Geo. IV. c. 51, towards the purchase of an annuity of L.585,740 for forty-four years from 5th of April 1823..........	....	10,897,880
By other credits, viz.		
Exchequer bills purchased......	2,700,000	9,166,860
Stock purchased....................	764,600	
City bonds............................	500,000	
Bills and notes discounted......	2,951,970	
Loans on mortgages..............	1,452,100	
London Dock Company..........	227,500	
Advances on security, and various articles.......................	570,690	
By cash and bullion................	....	5,293,150
By the permanent debt due from government...................	....	14,686,800
		L.44,179,630
Rest or surplus brought down......		2,637,760
Bank capital due to proprietors.....		14,553,000
		L.17,190,760

II.—*Account of the Amount of the Notes of the Bank of England in Circulation, of the Deposits in the hands of the Bank, of all Securities held by the Bank, of Bullion in her Coffers, and of the Rest or Surplus Capital of the Bank, on the last day of February in each of the following years.*

Years.	Notes in Circulation.	Deposits.	Public Securities.	Private Securities.	Bullion.	Rest, or Surplus Capital.
1778	7,440,330	4,662,150	7,198,292	3,322,228	2,010,690	1,128,730
1779	9,012,610	4,358,160	8,862,242	2,073,668	3,711,150	1,276,190
1780	8,410,790	4,723,890	9,145,659	1,755.371	3,581,060	1,347,410
1781	7,092,450	5,796,830	8,640,073	1,546,067	3,279,940	1,576,800
1782	8,028,880	6,130,300	10,346,055	3,448,015	2,157,860	1,792,750
1783	7,675,090	4,465,000	10,016,349	2,779,431	1,321,190	1,976,880
1784	6,202,760	3,903,920	7,789,291	3,829,929	655,840	1,168,380
1785	5,923,090	6,669,160	7,198,564	4,973,926	2,740,820	2,321,060
1786	7,581,960	6,151,660	6,836,459	3,516,781	5,979,090	2,598,710
1787	8,329,480	5,902,080	7,642,587	3,716,463	5,626,690	2,753,820
1788	9,561,120	5,177,050	7,833,857	4,030,653	5,743,440	2,869,780
1789	9,807,210	5,537,370	8,249,582	2,711,108	7,228,730	2,844,840
1790	10,040,540	6,223,270	8,347,387	1,984,733	8,633,000	2,701,310
1791	11,439,200	6,364,550	10,380,358	2,222,282	7,869,410	2,668,300
1792	11,307,380	5,523,370	9,938,799	3,129,761	6,468,060	2,705,870
1793	11,888,910	5,346,450	9,549,209	6,456,041	4,010,680	2,780,570
1794	10,744,020	7,891,810	9,950,756	4,573,794	6,987,110	2,875,830
1795	14,017,510	5,973,020	13,164,172	3,647,168	6,127,720	2,948,530
1796	10,729,520	5,702,360	12,951,812	4,188,028	2,539,630	3,247,590
1797	9,674,780	4,891,530	11,714,431	5,123,319	1,086,170	3,357,610
1798	13,095,830	6,148,900	11,241,333	5,558,167	5,828,940	3,383,710
1799	12,959,800	8,131,820	11,510,677	5,528,353	7,563,900	3,511,310
1800	16,844,470	7,062,680	13,975,663	7,448,387	6,144,250	3,661,150
1801	16,213,280	10,745,840	15,958,011	10,466,719	4,640,120	4,105,730
1802	15,186,880	6,858,210	14,199,094	7,760,726	4,152,950	4,067,680
1803	15,319,930	8,050,240	9,417,887	14,497,013	3,776,750	4,321,480
1804	17,077,830	8,676,830	14,684,686	12,314,284	3,372,140	4,616,450
1805	17,871,170	12,083,620	16,889,501	11,771,889	5,883,800	4,590,400
1806	17,730,120	9,980,790	14,813,599	11,777,471	5,987,190	4,867,350
1807	16,950,680	11,829,320	13,452,871	13,955,589	6,142,840	4,771,300
1808	18,188,860	11,961,960	14,149,501	13,234,579	7,855,470	5,088,730
1809	18,542,860	9,982,950	14,743,425	14,374,775	4,488,700	5,081,090
1810	21,019,600	12,457,310	14,322,634	21,055,946	3,501,410	5,403,080
1811	23,360,220	11,445,650	17,201,800	19,920,550	3,350,940	5,667,420
1812	23,408,320	11,595,200	22,127,253	15,899,037	2,983,190	6,005,960
1813	23,210,930	11,268,180	25,036,626	12,894,324	2,884,500	6,336,340
1814	24,801,080	12,455,460	23,630,317	18,359,593	2,201,430	6,937,800
1815	27,261,650	11,702,250	27,512,804	17,045,696	2,036,910	7,631,510
1816	27,013,620	12,388,890	19,425,780	23,975,530	4,640,880	8,639,680
1817	27,397,900	10,825,610	25,538,808	8,739,822	9,680,970	5,736,090
1818	27,770,970	7,997,550	26,913,360	3,991,970	10,055,450	5,192,270
1819	25,126,700	6,413,370	22,355,115	9,099,885	4,184,620	4,099,550
1820	23,484,110	4,093,550	21,715,168	4,472,322	4,911,050	3,520,880
1821	23,884,920	5,622,890	16,010,990	4,785,280	11,869,900	3,158,360
1822	18,665,350	4,689,940	12,478,133	3,494,947	11,057,150	3,674,940
1823	18,392,240	7,181,100	13,658,829	4,650,901	10,384,230	3,130,620
1824	19,736,990	10,097,850	14,341,127	4,530,873	13,810,060	2,847,220
1825	20,753,760	10,168,780	19,447,588	5,503,742	8,779,100	2,807,890
1826	25,467,910	6,935,940	20,573,258	12,345,322	2,459,510	2,974,240
1827	21,890,610	8,801,660	18,685,015	4,844,515	10,159,020	2,996,280
1828	21,980,710	9,198,140	19,818,777	3,762,493	10,347,290	2,749,710
1829	19,870,850	9,553,960	19,736,665	5,648,035	6,835,020	2,794,960
1830	20,050,730	10,763,150	20,038,890	4,165,500	9,171,000	2,561,510
1831	19,600,140	11,213,530	19,927,572	5,281,408	8,217,050	2,612,360
1832	18,051,710	8,937,170	18,497,448	5,836,042	5,293,150	2,637,760

III.—*Average Quarterly Account of the Liabilities, Assets, and Surplus or Rest, of the Bank of England, as ordered by the Act* 3 *and* 4 *Will. IV. cap.* 98.

	Notes in Circulation.	Deposits.	Securities.	Bullion.	Rest, or Surplus Capital.
1834.					
January 1	L.18,216,000	L.13,101,000	L.23,596,000	L.9,948,000	L.2,207,000
February 4	18,377,000	14,086,000	24,762,000	9,954,000	2,253,000
March 4	18,700,000	14,418,000	25,547,000	9,829,000	2,258,000
April 1	19,097,000	14,011,000	25,970,000	9,431,000	2,293,000
May 6	18,978,000	14,081,000	26,691,000	8,884,000	2,516,000
June 3	18.922,000	14,539,000	27,312,000	8,645,000	2,496,000
July 1	18,895,000	15,096,000	27,593,000	8,695,000	2,261,000
July 29	19,110,000	15,675,000	28,502,000	8,598,000	2,315,000
August 26	19,147,000	15,384,000	28,679,000	8.272,000	2,420,000
September 23	19,126,000	14,754,000	28,691,000	7,695,000	2,506,000
October 21	18,914,000	13,514,000	27,840,000	7,123,000	2,535,000
November 18	18,694,000	12,669,000	27,138,000	6,781,000	2,556,000
December 18	18,304,000	12,256,000	26,362,000	6,720,000	2,522,000
1835.					
January 15	18,012,000	12,585,000	26,390,000	6,741,000	2,534,000
February 10	18,099,000	12,535,000	26,482,000	6,693,000	2,541,000
March 10	18,311,000	13,281,000	26,657,000	6,536,000	2,681,000
April 7	18,591,000	11,289,000	16,328,000	6,329,000	2,677,000
May 5	18,542,000	10,726,000	25,764,000	6,197,000	2,693,000
June 2	18.460,000	10,568,000	25,562,000	6,150,000	2,684,000
June 30	18,315,000	10,954,000	25,678,000	6,219,000	2,628,000
July 28	18,322,000	11,561,000	26,244,000	6,283,000	2,644,000
August 25	18,340,000	12,308,000	26,964,000	6,326,000	2,642,000
September 22	18,240,000	13,230,000	27,888,000	6,261,000	2,679,000
October 20	17,930,000	14,227,000	28,661,000	6,186,000	2,690,000
November 17	17,549,000	16,180,000	30,069,000	6,305,000	2,645,000
December 15	17,821,000	17,729,000	31,048,000	6,626,000	2,624,000
1836.					
January 12	17,262,000	19,169,000	31,954,000	7,076,000	2,599,000
February 9	17,427,000	18,366,000	31,022,000	7,471,000	2,700,000
March 8	17,439,000	16,966,000	29,806,000	7,701,000	3,802,000
April 5	18,063,000	14,751,000	27,927,000	7,801,000	2,914,000
May 3	18,154,000	13,747,000	27,042,000	7,782,000	2,923,000
May 31	18,051,000	13,273,000	26,534,000	7,663,000	2,873,000
July 1	17,899,000	13,810,000	27,153,000	7,362,000	2,806,000
July 28	17,940,000	14,495,000	28,315,000	6,926,000	2,806,000
August 25	18,061,000	14,796,000	29,345,000	6,325,000	2,813,000
September 22	18,147,000	14,118,000	29,406,000	5,719,000	2,860,000
October 21	17,936,000	13,324,000	28,845,000	5,257,000	2,842,000
November 17	17.543,000	12,682,000	28,134,000	4,933,000	2,842,000
December 15	17,361,000	13,330,000	28,971,000	4,545,000	2,825,000
1837.					
January 10	17,422,000	14,354,000	30,365,000	4,287,000	2,876,000
February 7	17,868,000	14,230,000	31,085,000	4,032,000	3,019,000
March 7	48,178,000	13,260,000	30,579,000	4,048,000	3,189,000
April 4	18,432,000	11,192,000	28,843,000	4,071,000	3,263,000
May 2	18,480,000	10,472,000	28,017,000	4,190,000	3,255,000
May 30	18,419,000	10,422,000	27,572,000	4,423,000	3,154,000
June 27	18,202,000	10,424,000	26,932,000	4,750,000	3,056,000
July 25	18,261,000	10,672,000	26,727,000	5,226,009	3,020,000
August 22	18,462,000	11,005,000	26,717,000	5,754,000	3,004,000
September 19	18,814,000	11,093,000	26,605,000	6,303,000	3,001,000
October 17	18,716,000	10,501,000	25,316,000	6,856,000	2,955,000
November 14	18,344,000	10,242,000	23,985,000	7,432,000	2,831,000
December 14	17,998,000	10,195,000	22,727,000	8,172,000	2,706,000
1838.					
January 12	17,900,000	10,992,000	22,606,000	8,895,000	2,609,000

N. B.—The rest is found by adding together the circulation and deposits, and deducting their amount from the amount of the securities and bullion.

Joint-stock banks of England and Wales. How constituted.

It will be unnecessary, after the principles laid down and the details given in the previous parts of this article, to enter at any considerable length into an examination of the constitution of the joint-stock banks which combine with the business of deposit banks that of banks for the issue of paper. They consist of bodies of partners, varying from seven to nearly 1500, each holding one or more shares of the company's stock, and they are uniformly managed by boards of directors appointed by, and generally responsible to, the body of shareholders. The conditions of copartnery vary materially in different associations; but the above are distinguishing features common to them all. There can be no doubt that several of these banks are discreetly managed, possess adequate capital, and afford the amplest security to their customers and the public. But it is very doubtful whether this can be truly said of the greater number of these establishments. The shares in many joint-stock banks are very small, few being above L.100, the greater number not exceeding L.50, whilst many are only L.25, and some not more than L.10, and even L.5! Generally, too, it is understood, or rather it is distinctly set forth in the prospectus, that not more than five, ten, or twenty per cent. of these shares is to be called for, so that an individual who has ten or twenty shillings to spare may become a shareholder in a bank. And, owing to a practice, or rather a flagrant abuse, introduced into the management of various banks, by which they make large advances or discounts on the credit of the stock held by the shareholders, not a few individuals in doubtful, [or even desperate circumstances, take shares in them, in the view of obtaining loans, and bolstering up their credit! The great danger arising from such banks is obvious; and were one of them to stop payment, it is plain, even though the claims on it should be ultimately made good, that they could be so only at the cost, and perhaps ruin, of such of its proprietors as had abstained from the abusive practices resorted to by others. It may well, indeed, excite astonishment, that any one who can really afford to make a *bona fide* purchase of shares in a bank should be foolhardy enough to embark in such concerns.

A knowledge of the circumstances now stated, and of the sort of agency by which certain joint-stock banks have been established and conducted,[1] having been generally diffused, a secret committee was appointed by the House of Commons in 1836, to inquire into the operation of the act 7 Geo. IV. cap. 46, permitting the establishment of joint-stock banks; and whether it was expedient to make any alteration in its provisions. The report of this committee, and of a second committee appointed in 1837, with portions of the evidence taken before them, have since been published, and confirm all the conclusions of those who had contended that the existing system required material amendment. The committee of 1836 stated that,—

atements the mmittee 1836.

"Subject to the local restrictions imposed for the protection of the privilege of the Bank of England, it is open to any number of persons to form a company for joint-stock banking, whether for the purpose of deposit, or of issue, or of both.

"1. The law imposes on the joint-stock banks no preliminary obligation beyond the payment of a license duty, and the registration of the names of shareholders at the stamp-office.

"2. The law does not require that the deed of settlement shall be considered or revised by any competent authority whatever; and no precaution is taken to enforce the insertion in such deeds, of clauses the most obvious and necessary.

"3. The law does not impose any restrictions upon the amount of nominal capital. This will be found to vary from L.5,000,000 to L.100,000; and in one instance an unlimited power is reserved for issuing shares to any extent.

"4. The law does not impose any obligation that the whole or any certain amount of shares shall be subscribed for before banking operations commence. In many instances banks commence their business before one half of the shares are subscribed for, and 10,000, 20,000, and 30,000 shares are reserved to be issued at the discretion of the directors.

"5. The law does not enforce any rule with respect to the nominal amount of shares. These will be found to vary from L.1000 to L.5. The effects of this variation are strongly stated in the evidence.

"6. The law does not enforce any rule with respect to the amount of capital paid up before the commencement of business. This will be found to vary from L.105 to L.5.

"7. The law does not provide for any publication of the liabilities and assets of these banks, nor does it enforce the communication of any balance-sheet to the proprietors at large.

"8. The law does not impose any restrictions by which care shall be taken that dividends are paid out of banking profits only, and that bad or doubtful debts are first written off.

"9. The law does not prohibit purchases, sales, and speculative traffic on the part of these companies in their own stock, nor advances to be made on the credit of their own shares.

"10. The law does not provide that the guarantee fund shall be kept apart and invested in government or other securities.

"11. The law does not limit the number of branches, or the distance of such branches from the central bank.

"12. The law is not sufficiently stringent to insure to the public that the names registered at the stamp-office are the names of persons *bona fide* proprietors, who have signed the deed of settlement, and who are responsible to the public.

"13. The provisions of the law appear inadequate, or at least are disregarded, so far as they impose upon banks the obligation of making their notes payable at the places of issue.

"All these separate questions appear to your committee deserving of the most serious consideration, with a view to the future stability of the banks throughout the united kingdom, the maintenance of commercial credit, and the preservation of the currency in a sound state."

Remedial measures that should be adopted.

We do not, however, think that it would be at all necessary, in providing for a secure system of joint-stock banking, to make any regulations with respect to many of the points noticed by the committee, as to which the law is silent. At present every partner in a joint-stock bank is liable to the public for the whole debts of the firm; and this may be truly said to be the saving principle of the system, and without which it would be an unmixed intolerable evil. No individual should, however, by merely withdrawing from a joint-stock concern, get rid of his liabilities in connection with it. To prevent fraud, and to insure due caution, these ought to continue for a period of three years at least after he has publicly withdrawn his name. The public, too, are clearly entitled to know the partners in joint-stock associations, that is, to be informed who the individuals are with whom they are dealing, and who are responsible to them. But, unluckily, no effective means are taken for supplying the public with this necessary information, and, consequently, of properly discriminating between one establishment and another. The act of 1833 (3 and 4 Will. IV. c. 83) directed, as previously stated, that an account of the places where they carry on business, and of the names and residences of the partners, should be quarterly transmitted to the stamp-office. But doubts have been entertained as to the correctness of these returns, and comparatively little use has been, or indeed can be, made of them. The accounts of the names and residences of the proprietors are not published; but are carefully secluded from the public eye, in the repositories of Somerset House! It is true that these lists may be seen by those who choose to apply at the office, for a small fee, and that certified copies may be procured at no great expense. But few know that such returns exist, and still fewer have the opportunity or think of availing themselves of them as sources of information. To render them of any real utility, they should be brought under the public eye, by being hung up in the offices of the banks to which they refer, and periodically published in the newspapers of the places where they carry on business. By this means the public would know exactly to whom they had to look, and would act accordingly. They would not be deceived, as they are liable to be at present, by supposing that, because a bank has a number of partners, some of them must be opulent and trustworthy. They would know the precise state of the fact; and if it were seen from the quarterly returns, that opulent and intelligent individuals were withdrawing from any bank, every one would be put on his guard, and would naturally conclude that the parties had very sufficient reasons for quitting the concern. Thus far publicity may be made effectual, and would be of the very greatest importance. Neither is it possible to allege a single plausible objection to this proposal. It interferes in no degree, nor in any way, with the proceedings of the parties; all that it does is to declare who and what they are, and to this degree of publicity no honest man will object. But we have great doubts whether it be possible to carry publicity farther than this. The committee state that "the law does not provide for any publication of the liabilities and assets of these banks, nor does it enforce the publication of any balance-sheet to the proprietors at large;" and it has been proposed to compel the periodical publication of a statement of this sort. But it is very questionable whether any such publication would not be a great deal worse than useless. It is not proposed that commissioners should be appointed to inspect the accounts of the different banks, and to see that the returns are accurate. This would be too inquisitorial, too cumbrous, and too costly a plan to be thought of for a moment. There would be nothing for it, in fact, but to trust entirely to the honour of the parties. Hence, in all cases in which a disclosure would be really useful, the publication of an account of assets and liabilities would afford the means of deceiving the public, and of representing a bankrupt concern as being in a prosperous condition. Supposing, however, that the parties were in all instances perfectly honest, still the publication of a balance-sheet would be good for nothing. Every one knows how sanguine people are in relation to their own affairs; and that debts and obligations which other parties would hardly reckon worth any thing, are estimated by them as if they were so much bullion. But, independently of this, the futility of the thing is obvious. A bank with a capital of L.100,000 discounts bills and other obligations to the extent, perhaps, of L.300,000 or L.400,000; the fact that it has discounted them shows that it believes these bills and obligations to be good; and they will, consequently, be reckoned amongst its assets. But should a revulsion take place, or any circumstance occur to shake credit, these bills may not be worth L.100,000; and those who have dealt with the bank, on the hypothesis of its having capital and assets more than enough to meet all its obligations, will find to their cost that it is not possessed of a single shilling, but is, on the contrary, some L.200,000 or L.300,000 worse than nothing!

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[1] See Edinburgh Review, No. 128, art. 6; and the accounts of the Norwich Bank, and of the Northern and Central Bank, in the Reports of the Committees of 1836 and 1837.

The committee seem to think that some regulation should be enacted, providing that a certain portion of its capital should be paid up before a bank begins business. But we incline to think that the better way would be to prohibit all advertising of *nominal* capitals; and to enact that the capital actually *paid up*, whatever its amount, shall always be represented as, and held to be, the capital of the bank. But although such a regulation were made, there would be no security that the capital said to have been paid up had really been paid into the coffers of the bank, or that, if received, it had not again been lent out, in one way or other, to the partners. Perhaps it might be good policy to enact that no shares should be issued under a certain sum, as L.50; and that no loans should be made to the partners on the credit of their stock. But we should not be inclined to lay much stress on the former regulation; and the latter might, and no doubt would, be defeated in a thousand ways.

We are decidedly hostile to a proposal we have heard made, and which seems to be countenanced by the committee, for obliging all banks to establish a guarantee fund; that is, for obliging them to accumulate a portion of their profits as a reserve stock. But where is the security that such reserve would be always deducted from the profits? The truth is, that bankrupt and fraudulent concerns, and none else, would gain by such a regulation; inasmuch as it would enable them, by appearing to be prosperous, the better to deceive the public, and to blind them as to the real state of their affairs. It is plainly worse than absurd to teach the public to depend on guarantees that cannot be enforced, and which consequently must be good for nothing, unless it be to tempt to and conceal fraud. The knowledge of who the partners are in a bank, and their unlimited responsibility, are the only securities that, speaking generally, are worth anything. If these cannot protect the public from fraud and loss, nothing else will; and the question will come to be, not whether the system should be reformed, but whether it should be entirely abolished.

We have already noticed the extraordinary multiplication of branch-banks all over the country; and it is not very difficult to discover why banks of issue, at least, are so very anxious about the establishment of these outworks. They are bound, it seems, by the present law, to pay their notes only at the parent establishment; so that, by issuing them at a branch bank, perhaps a hundred miles distant from the head bank, the chances are ten to one that they will continue for a much longer period in circulation, and that they will consequently be able to carry on business with a much less amount of capital, than if they were, as they ought to be, obliged to pay their notes at the branches as well as at the principal office. It is obvious, indeed, that the convertibility of the paper, even of first-class banks, into either cash or Bank of England notes, is at present exceedingly imperfect; and that very great facilities are afforded for getting the worst class of notes into circulation, and for keeping them afloat, even after their quality may be suspected. This defect in the law ought undoubtedly to be amended, by obliging all banks that issue notes to pay them indifferently at any of their offices. But we incline to think that parliament might go farther than this, and that it should enact that no branch be established, whether for the issue of notes or otherwise, beyond a certain distance (say fifty miles) from the head office.

Several of the points recapitulated by the committee, as to which the law is silent, respect the rights and interests of the partners in joint-stock banks, in relation to each other, and not as between them and the public. But it is always a very difficult matter to interfere to dictate the footing on which parties in any undertaking should stand amongst themselves. Much should, in such cases, be left to the judgment of the parties; and public regulations, if enforced at all, should only go to prevent obvious and acknowledged abuse. The parties may in most cases be safely left to take care of themselves. The protection of the public interest is the paramount consideration; and we do not well know what can be done to effect this, in the case at least of such banks as do not issue notes, other than the making known who their partners are.

The committee, like the manager who overlooked the part of the prince in casting the play of Hamlet, have omitted all reference to by far the most important matter connected with their inquiry,—the suppression of the issues of private and joint-stock banks. Though the regulations proposed or hinted at by the committee were adopted, and were as effectual as they are sure to be ineffectual and mischievous, they would do nothing to prevent those oscillations in the amount and value of money inherent in a currency supplied by different issuers, and which periodically overspread the country with bankruptcy and ruin. Even the exacting of security for their issues, the only regulation it is possible to adopt in regard to them which can be of any real value, though it would mitigate their violence, would not get rid of these destructive fluctuations. Nothing, as has already been fully shown, can do this short of the suppression of all local issues; and all schemes for the improvement of banking in England which do not proceed on this assumption, savour more of quackery and delusion than of anything else, and deserve but little attention.

TABLES EXHIBITING THE NAMES, PARTNERS, CAPITAL, &C. OF JOINT-STOCK BANKS.

I.—Official Return of all Places where United or Joint-Stock Banks have been established under the Act 7 Geo. IV. c. 46; with the Dates when such Banks were established, and the Number of Partners therein, down to the 22d November 1837. Subjoined is the paid-up Capital and Circulation of certain Banks, according to the Returns rendered to the Secret Committee of 1837.

Places.	Name of the Bank.	Date when Established.	Number of Partners.	Paid-up Capital.			Circulation. Quarter ended Dec. 31, 1836.
				L.	*s.*	*d.*	*L.*
Ashton-under-Lyne	Ashton, Staleybridge, Hyde, and Glossop Bank	June 18, 1836.	317	20,330	0	0	..
Barnsley	*Barnsley Banking Company	Jan. 25, 1832.	112	25,100	0	0	8,247
Liverpool	Bank of Liverpool	April 23, 1831.	503	380,170	0	0	...
Manchester, Stockport, Bolton, and Newton	*Bank of Manchester	March 19, 1829.	677	741,030	0	0	136,366
Stockport	Bank of Stockport	May 3, 1836.	331	66,625	0	0	...
Walsall and Penkridge	*Bank of Walsall and South Staffordshire	August 10, 1835.	154	30,575	0	0	16,680
Kendal	*Bank of Westmoreland	June 8, 1833.	153	21,450	0	0	21,376
Bilston	*Bilston District Banking Company	August 31, 1836.	150	27,375	0	0	9,706
Birmingham	Birmingham and Midland Bank	August 18, 1836.	265	136,400	0	0	..
Ditto	Birmingham Town and District Banking Company	July 4, 1836.	398	...			...
Ditto	Birmingham Banking Company	Sept. 30, 1829.	298	50,000	0	0	...
Bolton	Bolton Joint-Stock Banking Company	May 30, 1836.	183	20,670	0	0	...
Bradford	*Bradford Banking Company	July 7, 1827.	167	77,900	0	0	33,019
Ditto	*Bradford Commercial Joint-Stock Banking Company	Feb. 27, 1833.	155	48,095	0	0	20,575
Bristol	*Bristol Old Bank	June 16, 1826.	7	140,000	0	0	104,352
Bury	Bury Banking Company	June 14, 1836.	110	63,925	0	0	8,256
Appleby, Carlisle, and Wigton	*Carlisle and Cumberland Banking Company	Oct. 8, 1836.	284	50,950	0	0	6,997
Cheltenham and Tewkesbury	Cheltenham and Gloucestershire Bank	May 19, 1836.	151	22,625	0	0	9,555
Chesterfield	*Chesterfield and North Derbyshire Banking Company	Dec. 21, 1831.	97	23,280	0	0	16,255
Manchester, Preston, Burnley, Birmingham, Chester, Leek, Burslem, Liverpool, Blackburn, Ashbourn, Rochdale, Shrewsbury, Ellesmere, Uttoxeter, Whitchurch, Hanley, Newport, and Ludlow	Commercial Bank of England	July 2, 1834.	664	262,485	0	0	113,527
Gloucester, Cheltenham, Burford, Cirencester, Farringdon, Tetbury, Dursley, Northleach, and Stroud	*County of Gloucester Bank	August 1, 1836.	281	176,750	0	0	87,424
Coventry and Nuneaton	Coventry and Warwickshire Banking Company	Dec. 13. 1835.	284	40,490	0	0	31,225
Ditto	Coventry Union Banking Company	May 12, 1836.	151	32,700	0	0	18,439
Workington, Cockermouth, Maryport, Wigton, and Penrith	*Cumberland Union Banking Company	March 13, 1829.	146	18,810	0	0	36,870

N.B.—The banks to which an asterisk is prefixed issue notes payable to bearer on demand. Where blanks are left no returns have been made.

Table I.—*Continued.*

Places.	Name of the Bank.	Date when Established.	Number of Partners.	Paid-up Capital.			Circulation. Quarter ending Dec. 31, 1836.
				L.	*s.*	*d.*	*L.*
Darlington, Stockton, Stokesley, Barnard Castle, Northallerton..	*Darlington District Joint-Stock Banking Company..................	Dec. 22, 1831.	250	55,425	0	0	73,285
Derby and Belper....................	*Derby and Derbyshire Banking Company	Dec. 28, 1833.	192	40,900	0	0	27,656
Plymouth, Devonport, Kingsbridge, Totness, Bodmin, Ashburton, St Austell, Liskeard, Dartmouth, Newton-Abbot, Exeter, Collumpton, Faristock, Crediton, and Launceston.......	*Devon and Cornwall Banking Company.............................	Dec. 31, 1831.	200	56,820	0	0	110,762
Dudley and Westbromwich........	*Dudley and Westbromwich Banking Company..................	Dec. 30, 1833.	185	32,325	0	0	42,030
Norwich, Great Yarmouth, Ipswich, Swaff'ham, Lynn, East Dereham, Foulsham, Fakenham, Harleston, Eye, Saxmundham, Bungay, Watton, Lowestoft, Beccles, Bury St Edmund's, North Walsham, Aylsham, Kenninghall, Thetford, Halesworth, Wrentham, Stowmarket, Woodbridge, Ixworth, Mildenhall, Downham............	*East of England Bank.............	Feb. 27, 1836.	541	156,322	10	0	84,574
Swansea and Neath..................	Glamorganshire Banking Company..	Sept. 8, 1836.	107	32,500	0	0	...
Gloucester, Stroud, Newnham, Evesham, Tewkesbury, Cheltenham..	*Gloucestershire Banking Company..	June 28, 1831.	248	100,000	0	0	76,132
Halifax and Huddersfield.........	Halifax and Huddersfield Union Banking Company.................	June 29, 1836.	408	83,775	0	0	44,549
Halifax....................................	Halifax Commercial Banking Company	June 21, 1836.	167	65,000	0	0	13,348
Ditto	*Halifax Joint-Stock Banking Company	Nov. 11, 1829.	207	44,475	0	0	25,395
Southampton, Fareham, Rumsey...	*Hampshire Banking Company.......	April 29, 1834.	152	28,445	0	0	26,466
Helston.....................................	*Helston Banking Company.........	August 4, 1836.	19	4,190	0	0	2,896
Hereford, Ross, Leominster, Ledbury, Kington, Hay, Monmouth, Coleford, Bromyard, and Abergavenny..................	*Herefordshire Banking Company...	August 5, 1836.	126	30,300	0	0	...
Huddersfield and Holmfirth..........	*Huddersfield Banking Company...	June 7, 1827.	326	65,180	0	0	38,580
Hull, Barton, Beverley, Brigg, Gainsborough, Goole, Grimsby, Lincoln, Louth, South Cave, Caistor, Market-Raisin, Retford, Howden, Snaith, and Market-Weighton................	*Hull Banking Company.............	Nov. 30, 1833.	239	44,200	0	0	74,960
Knaresborough, Ripon, Wetherby, Easingwold, Hemsley, Thirsk, Boroughbridge, Masham, Pateley Bridge, Otley, and Harrogate	*Knaresborough and Clare Banking Company..........................	Sept. 14, 1831.	162	21,620	0	0	37,944
Lancaster, Ulverstone, and Preston	*Lancaster Banking Company.	October 9, 1826.	127	60,750	0	0	48,701
Leamington Priors........................	*Leamington Bank.......................	May 8, 1835.	165	40,125	0	0	287
Leamington Priors, Southam, Warwick, Kenilworth, and Banbury	*Leamington Priors and Warwickshire Banking Company...	August 27, 1835.	111	22,920	0	0	24,145
Leeds..	*Leeds Banking Company...........	Nov. 22, 1832.	430	120,450	0	0	34,193
Ditto	Leeds Commercial Banking Company..	June 21, 1836.	216	50,000	0	0	21,975
Leeds and Bradford.....................	*Leeds and West Riding Banking Company	Nov. 28, 1835.	245	67,725	11	6	37,695
Leicester, Ashby-de-la-Zouch, Hinckley, Market-Harborough, and Melton-Mowbray...........	*Leicestershire Banking Company..	August 28, 1829.	139	49,440	0	0	36,332
Litchfield, Rugeley, Tamworth, and Birmingham.....................	Litchfield, Rugeley, and Tamworth Banking Company........	Nov. 21, 1835.	158	28,000	0	0	...
Lincoln, Gainsborough, Louth, Horncastle, Brigg, Market-Raisin, Caistor, Sleaford, Alford, Spilsby, Epworth, and Partney.	*Lincoln and Lindsay Banking Company..................................	Aug. 10, 1833.	225	53,510	0	0	67,055
Liverpool....................................	Liverpool Borough Bank.............	June 28, 1836.	407	206,225	0	0	...
Ditto	Liverpool Commercial Banking Company..........................	Dec. 29, 1832.	311	338,900	0	0	...

TABLE I.—*Continued.*

Places.	Name of the Bank.	Date when Established.	Number of Partners.	Paid-up Capital.			Circulation, Quarter ending Dec. 31, 1836.
				L.	s.	d.	L.
Manchester, Liverpool, Oldham, Warrington, Ashton-under-Lyne, Bury, Blackburn, Wigan, Preston, Staleybridge, Rochdale, Hyde, Stockport, Nantwich, Hanley, Stafford, Burslem, Leek, Lane-End, Cheadle, Rugeley, Market-Drayton, and Glossop	*Manchester and Liverpool District Bank	Nov. 26, 1829.	1302	749,725	0	0	...
Manchester	Manchester and Salford Bank	June 15, 1836.	239	271,900	0	0	...
Newport, Ponty-Pool, Usk, Chepstow, Cardiff, Sydney, Monmouth, Abergavenny, and Tredegar Iron-Works	Monmouthshire and Glamorganshire Banking Company	July 28, 1836.	341	128,580	0	0	32,879
Nottingham	*Moore and Robinson's Nottinghamshire Banking Company	July 12, 1836.	146	51,282	0	0	22,433
Aberystwith, Birmingham, Brecon, Llandovery, Hay, Bath, Shepton-Mallet, Boston, Castle Cary, Somerton, Bideford, Southmolten, Torrington, Bury St Edmund's, Cheltenham, Cardiff, Bridge-End, Dursley, Gloucester, Hereford, Honiton, Stowmarket, Ipswich, Woodbridge, Lichfield, Rugby, Tiverton, Wisbeach, Whittlesea, Chatteris, Long Sutton, Worcester, Ledbury, Wotton-under-Edge, Yarmouth, Bristol, Leicester, Dolgelly, Amlwch, Bala, Barnstaple, Okehampton, Cowbridge, Crewkerne, Darlington, Machynlleth, Exeter, Kington, Exmouth, Plymouth, Ilfracombe, Deal, Ramsgate, Wem, Kingsbridge, Whitchurch, Manchester, Newcastle, Emlyn, Stockton, Devonport, Pwllheli, Tremadoe, Portmadoc. Barnard Castle, Stokesley, Holbeach, March, Bromyard, Lowestoft, and Halesworth	*National Provincial Bank of England	Dec. 27, 1833.	800	367,635	0	0	329,480
Newcastle-upon-Tyne	*Newcastle Commercial Banking Co.	July 16, 1836.	134	40,425	0	0	4,372
Newcastle-upon-Tyne, North and South Shields, Sunderland, Durham, Alnwick, Alston, Morpeth, Hexham, Hartlepool, Blyth, and Bishop's Auckland	*Newcastle, Shields, and Sunderland Union Joint-Stock Banking Company	July 11, 1836.	446	115,168	10	0	58,798
Newcastle-upon-Tyne	Newcastle-upon-Tyne Joint-Stock Banking Company	June 27, 1836.	71	20,317	10	0	3,835
Liverpool, Dolgelly, Bangor, Machynlleth, Aberystwith, Holywell, Wrexham, Pwllheli, Bala, Denbigh, Oswestry, Llanidloes, Ruthin, Llanroost, Fastiniog, Mold, Newtown, Chester, Caernarvon, Llangefni, Welchpool, Bishop's Castle, Llangfyllin, and Holyhead	North and South Wales Bank	April 30, 1836.	529	150,360	0	0	52,358
Newcastle-upon-Tyne, Sunderland, North Shields, Berwick-upon-Tweed, Morpeth, Hexham, South Shields, Durham	North of England Joint-Stock Banking Company	Nov. 28, 1832.	625	240,000	0	0	105,670
Manchester	*Northern & Central Bank of England.	March 12, 1834.	1171	...			305,082
Northampton, Daventry, Wellingborough, Kettering, Stamford, and Market-Harborough	Northamptonshire Banking Company	May 23, 1836.	317	47,630	0	0	33,657
Northampton, Daventry, and Wellingborough	Northamptonshire Union Bank	May 13, 1836.	419	107,500	0	0	89,776
Newcastle-upon-Tyne, Sunderland, North and South Shields.	Northumberland and Durham District Banking Company	May 23, 1836.	304	123,812	10	0	...
Melksham, Devizes, Bradford, Trowbridge, Westbury, Calne, Chippenham, Warminster, Corsham, Wotten-Bassett, Marshfield, Swindon, Marlborough, Highworth, and Malmesbury	*North Wilts Banking Company	Nov. 6, 1835.	240	37,975	0	0	60,152

TABLE I.—*Continued.*

Places.	Name of the Bank.	Date when Established.	Number of Partners.	Paid-up Capital.			Circulation. Quarter ending Dec. 31, 1836.
				L.	s.	d.	L.
Nottingham, Newark, Mansfield, Loughborough, Worksop, and East Retford	*Nottingham and Nottinghamshire Banking Company	April 12, 1834.	341	81,450	0	0	52,522
Leicester, Hinckley, Loughborough, and Melton-Mowbray	*Pares's Leicestershire Banking Company, or the Leicestershire Union Banking Company	March 15, 1836.	46	16,350	0	0	30,138
Liverpool	Royal Bank of Liverpool	April 30, 1836.	258	352,930	0	0	...
Saddleworth, Ashton, and Oldham	*Saddleworth Banking Company	June 29, 1833.	110	30,850	0	0	20,790
Sheffield and Rotherham	*Sheffield Banking Company	June 24, 1831.	203	92,170	0	0	35,778
Sheffield	Sheffield and Hallamshire Banking Company	May 20, 1836.	617	115,057	10	0	18,771
Sheffield, Rotherham, and Bakewell	Sheffield and Rotherham Joint-Stock Banking Company	June 25, 1836.	275	33,125	0	0	48,295
Shiffnal, Wellington, Newport, and Coalbrook Dale	Shropshire Banking Company	May 27, 1836.	276	40,215	0	0	50,509
Manchester	South Lancashire Bank	May 25, 1836.	411	150,212	10	0	...
Stamford, Spalding, Boston, Oundle, Bourn, and Peterborough	*Stamford, Spalding, and Boston Joint.Stock Banking Company	Dec. 28, 1831.	88	44,080	0	0	68,748
Stourbridge, Kidderminster, and Stratford-upon-Avon	*Stourbridge and Kidderminster Banking Company	April 9, 1834.	220	45,000	0	0	67,167
Bristol, Axbridge, Bridgewater, Taunton, Wellington, Crewkerne, Chard, Ilminster, Langport, Wells, Glastonbury, Shepton Mallet, Bruton, Wincanton, Frome, Castle Cary, Yeovil, Bamwell, Weston-super-Mare, Williton, Martock, Somerton, South Petherton, Ilchester, Midsomer, Norton, and Stowey	*Stuckey's Banking Company	Oct. 9, 1836.	38	65,000	0	0	289,070
Liverpool	Union Bank of Liverpool	May 2, 1835.	341	257,350	0	0	...
Manchester	Union Bank of Manchester	May 6, 1836.	449	155,425	0	0	...
Wakefield	*Wakefield Banking Company	Oct. 25, 1832.	102	44,920	0	0	10,950
Warwick, Leamington, Stratford-on-Avon, Southam, Henley-in-Arden	*Warwick and Leamington Banking Company	Sept. 10, 1834.	125	32,900	0	0	43,505
Bristol, Bath, Barnstaple, Exeter, Swansea, Taunton, Bridgewater, Cardiff, Newport, Wells, Glastonbury, Merthyr Tydvil, Williton, Axbridge, and Somerton.	*West of England and South Wales District Bank	Dec. 23, 1834.	558	213,530	0	0	76,405
Salisbury, Warminster, Devizes, Trowbridge, Melksham, Chippenham, Marlborough, Malmesbury, Wootton-Bassett, Frome, Yeovil, Dorchester, Blandford, Wimborne, Poole, Bridport, Sherborne, Mere, Fordingbridge, Christchurch, Lymington, Paulton, Gillingham, and Marshfield	*Wilts and Dorset Banking Company	Jan. 11, 1836.	454	63,105	0	0	74,976
Devonport, Plymouth, Totnes, Kingsbridge, Falmouth, Penzance, Truro, and St Columb	*Western District Banking Company for Devon and Cornwall	Sept. 1, 1836.	312	...			17,880
Whitehaven and Penrith	*Whitehaven Joint-Stock Banking Company	May 25, 1829.	215	28,050	0	0	42,331
Wolverhampton	*Wolverhampton and Staffordshire Banking Company	Dec. 28, 1831.	234	69,435	7	2	51,228
York, Malton, Selby, Howden, Scarborough, and Boroughbridge	*York City and County Banking Company	March 2, 1830.	266	75,000	0	0	94,500
York, Driffield, Thirsk, Malton, and Burlington	*York Union Banking Company	April 23, 1833.	267	63,000	0	0	81,090
York, Whitby, Malton, Driffield, Pocklington, Hull, and Leeds	Yorkshire Agricultural and Commercial Banking Company	July 27, 1836.	604	72,875	0	0	16,224
Leeds, York, Hull, Sheffield, Halifax, Doncaster, Selby, Thirsk, Malton, Bradford, Pontefract, Ripon, Knaresborough, Huddersfield, Beverley, Richmond, Dewsbury, Wakefield, Settle, Northallerton, Barnsley, Skipton, Easingwold, Barnard Castle, and Otley	*Yorkshire District Bank	July 30, 1834.	1113	389,985	0	0	231,483
Whitehaven and Wigton	Bank of Whitehaven	Jan. 23, 1837.	123	...			...
Birmingham	Birmingham Borough Bank	March 28, 1837.	116	...			...

TABLE I.—*Concluded.*

Places.	Name of the Bank.	Date when Established.	Number of Partners.	Paid-up Capital.			Circulation Quarter ending Dec. 31, 1836.
				L.	*s.*	*d.*	*L.*
Carlisle and Cockermouth..........	Carlisle City and District Banking Company.........................	Feb. 20, 1837.	280	...			...
Liverpool..............................	Liverpool Albion Bank (formerly called Liverpool Tradesmen's Bank)............................	March 22, 1836.	434	94,375	0	0	...
Liverpool and St Helens..............	Liverpool Phœnix Bank.............	Jan. 26, 1837.	134	...			...
Liverpool..............................	Liverpool Banking Company (formerly called Liverpool United Trades' Bank)......................	May 12, 1836.	201	113,719	5	7	...
Oldham..................................	Oldham Banking Company...........	Sept. 30, 1836.	69	10,210	0	0	...
Richmond, Leyburn, and Bedale	Swaledale and Wensleydale Banking Company.........................	Dec. 30, 1836.	223	26,325	0	0	...
Huddersfield, Dewsbury, and Wakefield............................	West Riding Union Banking Company (formerly called Mirfield and Huddersfield Banking Company..................................	Dec. 29, 1832.	457	63,900	0	0	40,360
Southampton............................	Southern District Banking Company..	Nov. 22, 1837.	124	...			...

II.—An Account of the aggregate Number of Notes circulated in England and Wales by Private Banks, and by Joint-Stock Banks and their Branches, distinguishing Private from Joint-Stock Banks. From Returns directed by 3 and 4 William IV. c. 83.

Quarters Ended		Private Banks.	Joint-Stock Banks.	Total.
1833.	December 28.	8,836,803	1,315,301	10,152,104
1834.	March 29......	8,733,400	1,458,427	10,191,827
...	June 28........	8,875,795	1,642,887	10,518,682
...	September 27.	8,370,423	1,783,689	10,154,112
...	December 28.	8,537,655	2,122,173	10,659,828
1835.	March 28......	8,231,206	2,188,954	10,420,160
...	June 27........	8,455,114	2,484,687	10,939,801
...	September 26.	7,912,587	2,508,036	10,420,623
...	December 26.	8,334,863	2,799,551	11,134,414
1836.	March 26......	8,353,894	3,094,025	11,447,919
...	June 25........	8,614,132	3,588,064	12,202,196
..	September 24.	7,764,824	3,969,121	11,733,945
...	December 31.	7,753,500	4,258,197	12,011,697
1837.	April 1.........	7,275,784	3,755,279	11,031,063
...	July 1..........	7,187,673	3,684,764	10,872,437
...	September 30.	6,701,996	3,440,053	10,142,049
...	December 30.	7,043,470	3,826,665	10,870,135

III.—A Return of Joint-Stock Banks in Ireland, with the Dates of their Establishment, the Names of the several Towns and Places where such Banks and their Branches have been Established, and the Number of Partners in each.

Joint-Stock Banks.	When Established.	Towns and Places where the Banks or their Branches have been Established.	Number of Partners.
Hibernian Joint Stock Company.	June 1825, By Special Act, 5 Geo. IV. c. 159.	Dublin.	225
Provincial Bank of Ireland.	Sept. 1825, Under General Act, 6 Geo. IV. c. 42.	Armagh. Athlone. Banbridge. Bandon. Ballina. Ballymena. Ballyshannon. Belfast. Cavan. Coleraine. Clonmell. Cootehill. Cork. Downpatrick. Dungannon. Dungarvan. Ennis. Enniskillen. Galway. Kilkenny. Limerick. Londonderry. Lurgan. Mallow. Monaghan. Moneymore. Omagh. Parsonstown. Strabane. Sligo. Tralee. Waterford. Wexford. Youghal.	707
Northern Banking Company.	Dec. 31, 1825.	Armagh. Belfast. Ballymena. Coleraine. Carrickfergus. Downpatrick. Lisburn. Londonderry. Lurgan. Magherafelt. Newton Limavady.	207
Belfast Banking Company.	July 31, 1827.	Armagh. Aughnacloy. Ballymena. Ballymoney. Belfast. Banbridge. Coleraine. Cookstown. Dungannon. Londonderry. Lurgan. Larne. Letterkenny. Monaghan. Magherafelt. Ne. Limavady. Newtown Ardes. Portadown. Strabane. Stewartstown. Tanderagee.	285

TABLE III.—*Continued.*

Joint-Stock Banks.	When Established.	Towns and Places where the Banks or their Branches have been Established.	Number of Partners.
Agricultural and Commercial Bank of Ireland.	Oct. 28, 1834.	Armagh. Ballina. Ballinasloe. Ballymena. Bandon. Belfast. Boyle. Castlebar. Cavan. Clifden. Clones. Coleraine. Cork. Dungannon. Ennis. Enniscorthy. Enniskillen. Fermoy. Galway. Kanturk. Kilkenny. Kilrush. Killarney. Kinsale. Limerick. Londonderry. Longford. Loughrea. Mallow. Nenagh. New Ross. Omagh. Parsonstown. Roscrea. Roscommon. Skibbereen. Sligo. Strabane. Strokestown. Thomastown. Thurles. Tipperary. Tuam. Waterford. Lurgan. Tralee. Donegal.	3892
National Bank of Ireland.	Jan. 24, 1835.	Athlone. Boyle. Castlebar. Castlerea. Ballinasloe. Galway. Kilkenny. Longford. Loughrea. Moale. Roscommon. Sligo. Tuam.	290
Limerick National Bank of Ireland.	Aug. 17, 1835.	Limerick. Charleville. Ennis. Kilrush. Rathkeale.	553
Clonmel National Bank of Ireland.	May 20, 1836.	Clonmel. Cashel. Thurles.	487
Carrick-on-Suir National Bank of Ireland.	May 21, 1836.	Carrick-on-Suir.	416
Waterford National Bank of Ireland.	May, 23, 1836.	Waterford. Dungarvan. New Ross. Tallow.	451

TABLE III.—*Concluded.*

Joint-Stock Banks.	When Established.	Towns and Places where the Banks or their Branches have been Established.	Number of Partners.
Wexford and Enniscorthy National Bank of Ireland.	May 24, 1836.	Wexford. Enniscorthy.	416
Tipperary National Bank of Ireland.	May 26, 1836.	Tipperary. Fermoy. Mitchelstown. Nenagh. Roscrea.	458
Tralee National Bank of Ireland.	May 27, 1836.	Tralee. Caherciveen. Dingle. Kanturk. Killarney. Tarbert.	444
Kilkenny National Bank of Ireland.	June 7, 1837.	Kilkenny.	379
Cork National Bank of Ireland.	March 17, 1837.	Cork.	415
Ulster Banking Company.	April 15, 1836.	Antrim. Armagh. Belfast. Banbridge. Ballymoney. Comber. Downpatrick. Enniskillen. Lurgan. Monaghan. Portadown. Tanderagee.	789
Royal Bank of Ireland.	November 1836.	Dublin.	363
Southern Bank of Ireland.	Feb. 11, 1837.	Cork.	92

History and constitution of Scotch banks.

The act of 1708, preventing more than six individuals from entering into a partnership for carrying on the business of banking, did not extend to Scotland. In consequence of this exemption, several banking companies, with numerous bodies of partners, have always existed in that part of the empire. The Bank of Scotland was established by act of parliament in 1695. By the terms of its charter, it enjoyed, for twenty-one years, the exclusive privilege of issuing notes in Scotland. Its original capital was only L.100,000. But it was increased to L.200,000 in 1744, and now amounts to L.1,500,000, of which L.1,000,000 has been paid up.

The Royal Bank of Scotland was established in 1727. Its original capital was L.151,000. At present it amounts to L.2,000,000, which has been all paid up.

The British Linen Company was incorporated in 1746, for the purpose, as its name implies, of undertaking the manufacture of linen. But the views in which it originated were speedily abandoned, and it became a banking company only. Its paid up capital amounts to L.500,000.

Exclusively of the above, there are two other chartered banks in Scotland; the Commercial Bank, established in 1810, and the National Bank of Scotland, established in 1825. The former has a paid-up capital of L.600,000, and the latter of L.500,000.

None of the other banking companies established in Scotland are chartered associations; and the partners are jointly and individually liable to the whole extent of their fortunes for the debts of the firms. Some of them, as the Aberdeen Town and County Bank, the Dundee Commercial Bank, the Perth Banking Company, &c. have very numerous bodies of partners. Generally speaking, they have been eminently successful. An original share, L.150, of the stock of the Aberdeen Banking Company, established in 1767, is now (1838) worth no less that L.2500! Their affairs are uniformly conducted by a board of directors chosen by the shareholders.

There are very few banks with less than six partners in Scotland. Almost all the great joint-stock banks have numerous branches, so that there is hardly a town or village of any consequence without two or more banks.

The Bank of Scotland began to issue one-pound notes as early as 1704, and their issue has since been continued without interruption. With only one exception, all the Scotch banks issue notes; and, taking their aggregate circulation at from L.3,500,000 to L.4,000,000, it is supposed that from L.2,000,000 to L.2,500,000 consists of notes for L.1. In 1826 it was proposed to suppress one-pound notes in Scotland as well as in England; but the measure having been strongly objected to by the people of Scotland, as being at once oppressive and unnecessary, was abandoned.

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There have been very few bankruptcies amongst the Scotch banks. This superior stability is to be ascribed to a variety of causes; partly to the great wealth of the early established banks, which had a considerable influence in preventing an inferior class of banks acquiring any hold on the public confidence; partly to the comparatively little risk attending the business of banking in Scotland; partly to the facilities afforded by the Scotch law for attaching a debtor's property, whether it consist of land or moveables; and partly and principally, perhaps, to the fact of the Scotch banks being but indirectly and slightly affected by a depression of the exchange and an efflux of bullion.

ppres- n of lo- notes Scotland neces- y.

The circumstances now mentioned render it unnecessary to enforce that suppression of local issues in Scotland which is so indispensable in England, where the system of provincial banking is of a very inferior description, the risk attending the business much greater, and where any excess in the amount of the currency necessarily occasions a fall of the exchange and a demand for bullion. The commerce and population of Scotland are too limited, and that country is too remote from the metropolis, or from the centre of the monied world, the pivot on which the exchanges turn, to make it of importance that her currency should be identical with that of England. We believe that the Scotch attach much more importance than it deserves to the issue of paper, and especially to the issue of one-pound notes; still, however, we do not think that the circumstances are at present such as to call for or warrant any attempt to introduce any material changes in their banking system.

posits.

All the Scotch banks receive deposits, even of the low amount of L.10, and allow interest on them at from one to two per cent. below the market rate. But should a deposit be unusually large, as from L.5000 to L.10,000, a special agreement is usually made with regard to it. This part of the system has been particularly advantageous. It, in fact, renders the Scotch banks a sort of savings' banks for all classes; and their readily receiving all sorts of deposits at a reasonable rate of interest, has tended to diffuse a spirit of economy and parsimony among the people that would not otherwise have existed. The total deposits in the hands of the Scotch banks are believed at present (1838) to exceed L.25,000,000, of which fully a half is understood to be in sums of from L.10 to L.200.

Cash-accounts.

The Scotch banks make advances in the way of discounts and loans, and on what are called cash-credits or cash-accounts. By the latter are meant credits given by the banks for specified sums to individuals, each of whom gives a bond for the sum in his account, with two or more individuals as sureties for its payment. Persons having such accounts draw upon them for whatever sums within their amount they have occasion for, repaying these advances as they find opportunity, but generally within short periods. Interest is charged only on the average balance which may be found due to the bank. The total number of these accounts in Scotland in 1826 was estimated at about 12,000; and it may now, perhaps, be taken at about 14,000. They are believed to average about L.500; few are for less than L.100, and fewer still above L.5000.

It has been contended, and by no less an authority than Adam Smith, that this species of accommodation gives the Scotch merchants and traders a double command of capital. "They may discount their bills of exchange," says he, "as easily as the English merchants, and have, besides, the additional conveniency of their cash-accounts."[1] But this is an obvious error. The circulation will take off only a certain quantity of paper; and to whatever extent it may be issued by means of cash-accounts, so much the less can be issued in the way of discounts. The advantage of a cash-account does not really consist in its enabling a banker to enlarge his advances to his customers, but in the extreme facility it affords of making them. An individual who has obtained such an account may operate upon it at any time he pleases, and by drafts for any amount; an advantage he could not enjoy to any thing like the same extent, without an infinite deal of trouble and expense, were the loans or advances made to him through the discounting of bills.

The Scotch banks draw upon London at twenty days' date. This is denominated the par of exchange between London and Edinburgh.

The following table, extracted from a very useful publication,[2] exhibits the partners, branches, capital, prices of shares, dividends, &c. in the five chartered banks, in December 1837; and it also shows the aggregate partners, branches, capital, &c. of the other joint-stock banks then existing in Scotland.

	Partners.	Branches.	Paid up Capital.	Dividend.			Shares Paid.			Present Price.
				Rate per Cent.	Amount.	Payable.				
			L.		L.		L.	s.	d.	L.
Bank of Scotland	672	25	1,000,000	6	60,000	April & Oct.	83	6	8	159
Royal Bank	764	7	2,000,000	5½	110,000	Jan. & July.	100	0	0	161
British Linen Company	164	42	500,000	8	40,000	June & Dec.	100	0	0	236
	1600	74	3,500,000	6	210,000					
Commercial Bank	521	48	600,000	6	36,000	Jan. & July.	100	0	0	173
National Bank	1238	33	500,000	6	30,000	Ditto.	10	0	0	16
Twelve other Joint-Stock Cos.	4128	72	1,937,700	6·04	116,995					
Total	7487	227	6,537,700	6·01	392,995					

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[1] Wealth of Nations, book ii. cap. 2.

[2] Oliver and Boyd's Almanack for 1838.

System of banking in Ireland.

"In no country, perhaps," says Sir Henry Parnell, "has the issuing of paper-money been carried to such an injurious excess as in Ireland. A national bank was established in 1783, with similar privileges to those of the Bank of England, in respect to the restriction of more than six partners in a bank; and the injury that Ireland has sustained from the repeated failure of banks may be mainly attributed to this defective regulation. Had the trade of banking been left as free in Ireland as it is in Scotland, the want of paper-money that would have arisen with the progress of trade, would in all probability have been supplied by joint-stock companies supported with large capitals, and governed by wise and effectual rules.

"In 1797, when the Bank of England suspended its payments, the same privilege was extended to Ireland; and after this period the issues of the Bank of Ireland were rapidly increased. In 1797, the amount of the notes of the Bank of Ireland in circulation was L.621,917; in 1810, L.2,266,471; and in 1814, L.2,986,999.

"These increased issues led to corresponding increased issues by the private banks, of which the number was fifty in the year 1804. The consequence of this increase of paper was its great depreciation; the price of bullion and guineas arose to ten per cent. above the mint price; and the exchange with London became as high as eighteen per cent., the par being 8$\frac{1}{3}$. This unfavourable exchange was afterwards corrected, not by any reduction in the issues of the Bank of Ireland, but by the depreciation of the British currency in the year 1810, when the exchange between London and Dublin settled again at about par. (See article EXCHANGE.)

"The loss that Ireland has sustained by the failure of banks may be described in a few words. It appears, by the Report of the Committee on Irish Exchanges in 1804, that there were at that time in Ireland fifty registered banks. Since that year a great many more have been established, but the whole have failed, one after the other, involving the country from time to time in immense distress, with the following exceptions:—*First*, a few that withdrew from business; *secondly*, four banks in Dublin; *thirdly*, three at Belfast; and, *lastly*, one at Mallow. These eight banks, with the new Provincial Bank and the Bank of Ireland, are the only banks now (1827) existing in Ireland.

"In 1821, in consequence of eleven banks having failed nearly at the same time, in the preceding year, in the south of Ireland, government succeeded in making an arrangement with the Bank of Ireland, by which joint-stock companies were allowed to be established at a distance of fifty miles (Irish) from Dublin, and the bank was permitted to increase its capital L.500,000. The act 1 and 2 Geo. IV. c. 72, was founded on this agreement. But ministers having omitted to repeal in this act various restrictions on the trade of banking that had been imposed by 33 Geo. II. c. 14, no new company was formed. In 1824 a party of merchants of Belfast, wishing to establish a joint-stock company, petitioned parliament for the repeal of this act of Geo. II.; and an act was accordingly passed in that session, repealing some of its most objectionable restrictions. (5 Geo. IV. c. 73.)

"In consequence of this act, the Northern Bank of Belfast was converted into a joint-stock company, with a capital of L.500,000, and commenced business on the 1st of January 1825. But the restrictions of 33 Geo. II., and certain provisions contained in the acts 1 and 2 Geo. III., and 5 Geo. IV., obstructed the progress of this company, and they found it necessary to apply to government to remove them; and a bill was accordingly introduced, which would have repealed all the obnoxious clauses of the 33d Geo. II., had it not been so altered in the committee as to leave several of them in force. In 1825 the Provincial Bank of Ireland commenced business with a capital of L.2,000,000; and the Bank of Ireland has of late established branches in all the principal towns.

"The losses that have been sustained in Ireland by abusing the power of issuing paper have been so great, that much more is necessary to be done by way of protecting the public from future loss, than the measure proposed last session (1826) by ministers, of abolishing small notes, and the measure already adopted, of allowing joint-stock companies to be established in the interior of the country. As the main source of the evil consists in the interference of the law in creating a national bank with exclusive privileges, the first step that ought to be taken for introducing a good system into Ireland, is the getting rid of such a bank, and opening the trade of banking in Dublin. The next measure should be the requiring of each bank to give security for the amount of paper that is issued; for after the experience of the ignorance with which the Irish banks have conducted their business, and the derangement of the natural course of the trade, by the long existence of the Bank of Ireland, it would be unwise to calculate upon a sound system of banking speedily supplanting that which has been established.

"Under the circumstances in which Ireland is placed, nothing would so much contribute to her rapid improvement in wealth, as the introducing of the Scotch plan of cash credits, and of paying interest on deposits. By cash credits, the capital which now exists would be rendered more efficient, and the paying of interest on small deposits, would lead to habits of economy, and to the more rapid accumulation of new capital.

"The charter of the Bank of Ireland has still to run till the year 1838."[1]

Since Sir Henry Parnell published the valuable pamphlet from which we have taken the foregoing extract, several joint-stock banking companies have been founded in Ireland. The Provincial Bank, to which Sir Henry alludes, has a paid up-capital of L.500,000, and has been well and profitably managed. But others have been less fortunate. The Agricultural and Commercial Bank of Ireland, established in 1834, with 2170 partners, a paid-up capital of L.352,790, and many branches, stopped payment during the pressure in November 1836, and by doing so involved many persons in great distress. It would appear, from the statement of the auditors appointed to audit the accounts, &c. of this bank, given in the Appendix to the Commons' Report of 1837, that it had, to say the least, been very ill managed. "We have found," say the auditors, "that there was no efficient control over the branches, and that the system of inspection was most imperfect. A complete absence of plan for checking the accounts existed at the head office in Dublin; and *the book-keeping has been so faulty, that we are convinced no accurate balance-sheet could at any time have been constructed*. We have looked in vain for an account of 'outfit,' or of 'premiums' received; and we must add, that the personal accounts at the head office require a diligent and searching revision."

More than half of the existing Irish joint-stock banks, amounting to eighteen, were established in 1836 and 1837. It is to be hoped that these establishments will take warning by the disasters in which the Agricultural Bank has been involved, and adopt a safer course. But if the power to issue paper-money be continued to these establishments, it is clear that no time should be lost in compelling them to give security for its payment. Unless this measure be inforced, or the issues be entirely suppressed, we run little risk in affirming that Ireland has not seen either the last or most severe of those violent oscillations in the amount and value of money which produce so much bankruptcy and ruin.

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[1] Observations on Paper-Money, &c. by Sir Henry Parnell, pp. 171–177.

The capital of the Bank of Ireland amounts to L.2,769,230. The rate of dividend from 1830 to 1836 was nine per cent.; in 1836 it was eight and a half per cent. The charter, which expires in the course of the present year, has not as yet been renewed. It is almost needless to add, that there is no room or ground whatever for the continuance of the exclusive privilege the Bank of Ireland has hitherto enjoyed. We subjoin an

Account showing the Circulation of the Bank of Ireland from 1823 *to* 1836, *both inclusive.*

Years.	Large Notes.	Small Notes.	Post Bills.	Total Average Circulation.
	L.	L.	L.	L.
1823	1,827,700	1,383,600	1,859,100	5,070,500
1824	1,938,200	1,451,600	2,190,800	5.579,700
1825	1,969,300	1,677,500	2,662,500	6,309,300
1826	1,502,700	2,644,200	1,758,000	4,905,000
1827	1,460,300	1,491,800	1,411,300	4,363,600
1828	1,540,200	1,668,800	1,375,900	4,585,000
1829	1,615,200	1,459,300	1,362.700	4,437,300
1830	1,541,800	1,385,100	1,147,700	4,074,700
1831	1,488,600	1,399,300	1,025,000	3,913,000
1832	1,534,400	1,519.600	1,028,900	4,083,100
1833	1,600,600	1,472.300	943,400	4.016,500
1834	1,608,400	1,363,300	862,700	3,834,500
1835	1,623,400	1,249,800	763,600	3,636,900
1836	1,708,500	1,087,400	633,200	3,429,300

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It would far exceed our limits to enter into any detailed statements with respect to the banks and banking systems of foreign countries; we shall therefore confine ourselves to a brief notice of such banks as have been most celebrated, or are at present of the greatest importance.

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The Bank of Venice was the most ancient bank in Europe. Neither its date nor the circumstances which led to its establishment are exactly known. Historians inform us, that in 1171, the republic being hard pressed for money, levied a forced contribution on the richest citizens, giving them in return a perpetual annuity at the rate of four per cent. An office was established for the payment of this interest, which, in the sequel, became the Bank of Venice. This might be effected as follows: The interest on the loan to government being paid punctually, every claim registered in the books of the office would be considered as a productive capital; and these claims, or the right of receiving the annuity accruing thereon, must soon have been transferred, by demise or cession, from one person to another. This practice would naturally suggest to holders of stock the simple and easy method of discharging their mutual debts by transfers on the office books, and as soon as they became sensible of the advantages to be derived from this method of accounting, bank-money was invented.

The Bank of Venice was essentially a deposit bank. Though established without a capital, its bills bore at all times an agio or premium above the current money of the republic. The invasion of the French in 1797 occasioned the ruin of this establishment.

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The Bank of Amsterdam was founded in 1609, on strictly commercial principles and views, and not to afford any assistance, or to commix with the finances of the state. Amsterdam was then the great entrepôt of the commerce of the world, and of course the coins of all Europe passed current in it. Many of them, however, were so worn and defaced as to reduce their general average value to about nine per cent. less than their mint value; and, in consequence, the new coins were immediately melted down and exported. The currency of the city was thus exposed to great fluctuations; and it was chiefly to remedy this inconvenience, and to fix the value or par of the current money of the country, that the merchants of Amsterdam established a "bank," on the model of that of Venice. Its first capital was formed of Spanish ducats or ducatoons, a silver coin which Spain had struck in the war with Holland, and with which the tide of commerce had enriched the country it was formed to overthrow! The bank afterwards accepted the coins of all countries, worn or new, at their intrinsic value, and made its own bank-money payable in standard coin of the country, of full weight, deducting a "brassage" for the expense of coinage, and giving a credit on its books, or "bank-money," for the deposits.

The Bank of Amsterdam professed not to lend out any part of the specie deposited with it, but to keep in its coffers all that was inscribed on its books. In 1672, when Louis XIV. penetrated to Utrecht, almost every one who had an account with the bank demanded his deposit, and these were paid off so readily, that no suspicion could exist as to the fidelity of the administration. Many of the coins then brought forth bore marks of the conflagration which happened at the Hôtel de Ville, soon after the establishment of the bank. This good faith was maintained till about the middle of last century, when the managers secretly lent part of their bullion to the East India Company and government. The usual "oaths of office" were taken by a religious magistracy, or rather by the magistracy of a religious people, that all was safe; and the good people of Holland believed, as an article of their creed, that every florin which circulated as bank-money, had its metallic constituent in the treasury of the bank, sealed up and secured by oaths, honesty, and good policy. This blind confidence was dissipated in December 1790, by a declaration that the bank would retain ten per cent. of all deposits, and would return none of a less amount than 2500 florins.

Even this was submitted to and forgiven. But, four years afterwards, on the invasion of the French, the bank was obliged to declare that it had advanced to the states of Holland and West Friesland, and the East India Company, more than 10,500,000 florins, which sum they were unable to make up to their depositors, to whom, however, they assigned their claims on the states and the company. Bank-money, which previously bore an agio of five per cent., immediately fell to sixteen per cent. below current money.

This epoch marked the fall of an institution which had long enjoyed an unlimited credit, and had rendered the greatest services. The amount of the treasure in the vaults of the bank, in 1755, was estimated by Mr Hope at 33,000,000 of florins.[1]

Bank of
Hamburg.

The Bank of Hamburg was established in 1619, on the model of that of Amsterdam. It is a deposit bank, and its affairs are managed according to a system that insures the fullest publicity. It receives no deposits in coin, but only in bullion of a certain degree of fineness. It charges itself with the bullion at the rate of 442 schillings the mark, and issues it at the rate of 444 schillings, being a charge of four ninths, or nearly one half per cent., for its retention. It advances money on jewels to three fourths of their value. The city is answerable for all pledges deposited with the bank: they may be sold by auction if they remain one year and six weeks without any interest being paid. If the value be not claimed within three years, it is forfeited to the poor. This bank is universally admitted to be one of the best managed in Europe.

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[1] Storch, *Cours d'Economie Politique*, tom. iv.

Banks.

Bank of France.

The Bank of France was founded in 1803. The exclusive privilege of issuing notes payable to bearer was granted to it for forty years. The capital of the bank consisted at first of 45,000,000 francs, but it was subsequently increased to 90,000,000 francs, divided into 90,000 shares or *actions* of 1000 francs each. Of these shares, 67,900 are in the hands of the public; 22,100, being purchased up by the bank, form part of her capital. The notes issued by the bank are for 1000 and 500 francs. The dividend varies from six to ten and a half per cent., the latter being its amount in 1837; and there is, besides, a *reserve* retained from the profits, which is vested in the five per cents. A bonus of 200 francs a share was paid out of this reserve to the shareholders in 1820. No bills are discounted that have more than three months to run. The customary rate of discount is four per cent., but it varies according to circumstances. The discounts in 1834 amounted to 306,603,000 francs, but they vary materially from year to year, and are sometimes more than double this amount. The bank is obliged to open a *compte courant* for every one who requires it; and performs services for those who have such accounts, similar to those rendered by the private banks of London to their customers. She is not allowed to charge any commission upon current accounts, so that her only remuneration arises out of the use of the money placed in her hands by the individuals whose payments she makes. This branch of the business is said not to be profitable. There are about 1600 accounts current at the bank; and of the entire expenses of the establishment, amounting to about 900,000 francs a year, *two thirds* are said to be incurred in this department. The bank advances money on pledges of different kinds, such as foreign coin or bullion, government or other securities, &c. It also undertakes the care of valuable articles, as plate, jewels, bills, title-deeds, &c. The charge is one eighth per cent. of the value of each deposit for every period of six months or under. The average circulation of bank notes in 1834 was 207,321,000 francs, the price of a share of the bank's stock on the 8th of January 1838 was 2555 francs, a proof that its condition is believed to be eminently flourishing.

The administration of the bank is vested in a council general of twenty members, viz. seventeen regents, and three censors, who are nominated by two hundred of the principal proprietors. The king appoints the governor and deputy governor. The first must be possessed of a hundred and fifty, and the latter of fifty shares. A *compte rendu* is annually published, and a report by the censors, which together give a very full exposition of the affairs of the bank. The institution is flourishing, and enjoys unlimited credit. (For further details with respect to the Bank of France, see Storch, *Cours d'Economie Politique*, Paris, 1823, tom. iv. pp. 168–180; and the *Comptes Rendus* of the different years.)

For further information as to continental banks and paper-money, the reader is referred to the interesting chapter on that subject in the fourth volume of the *Cours d'Economie Politique* of M. Storch, and to M'Culloch's *Commercial Dictionary*.

System of banking in the United States.

The system of banking in the United States has recently attracted a great deal of attention in this country. The Bank of the United States was incorporated by Congress in 1816, with a capital of 35,000,000 dollars, for the issue of notes and the transacting of ordinary banking business. Its head office was in Philadelphia, but it had branches that carried on an extensive business in most considerable towns of the Union. The charter was limited to twenty years' duration; and the question, whether it should be renewed, was debated with extraordinary vehemence in all parts of America. The late president, General Jackson, was violently opposed to the reincorporating of the bank, and rejected a bill for that purpose, that had been sanctioned by the other two branches of the legislature. A majority of Congress having come round to the president's views, the charter was allowed to expire. It has since, however, received a new charter from the state of Pennsylvania. But this merely enables it to carry on business in that state; though it may obtain, and has, in fact, already obtained leave from some of the other states to establish branches within their limits. It is, however, no longer a national or government bank; but it is now, as formerly, the first monied institution of the new world, and in this respect, indeed, is second only to the Bank of England.

Banks.

We cannot help thinking, that the American government acted throughout the whole of this affair on the most erroneous views. Banking in America is, if possible, in a still worse condition than in England; and there can hardly be a doubt that the establishment of the Bank of the United States was of signal service to the republic, by affording a currency of undoubted solidity, readily accepted in all parts of the Union, and by its operating as a salutary check on the conduct of other banks. General Jackson, and the party of which he was the head, have, or affect to have, a great horror of paper-money. But it would be practising too much on the patience of our readers were we to endeavour to prove by argument the great utility, not to say necessity, of a paper currency of some sort or other, to all great commercial countries like the United States. To suppose that it should be altogether dispensed with, is as absurd as it would be to suppose that they should dispense with their improved roads and carriages. A wise statesman should not attempt to suppress what is indispensable, but should exert himself to obviate its defects, and to make it as suitable as it can be made to the objects in view. This, however, General Jackson and his party have not done. On the contrary, they declared war against the only unexceptionable bank in the Union, and to injure it gave full scope to the rest. Hence, instead of obviating any one of the gross defects inherent in the existing banking system, the proceedings of General Jackson have aggravated and multiplied them in in no common degree; and it is now infected with every vice that it seems possible can belong to banking.

The American banks are all joint-stock associations. But instead of the partners being liable, as in England, for the whole amount of the debts of the banks, they are in general liable only for the amount of their shares, or for some fixed multiple thereof. It is needless to dwell on the temptation to commit fraud held out by this system, which has not a single countervailing advantage to recommend it. The worthlessness of the plan on which the banks were founded was evinced by the fact, that between 1811 and the 1st of May 1830, no fewer than a hundred and sixty-five banks became altogether bankrupt, many of them paying only an insignificant dividend; and this exclusive of a much greater number that stopped for a while, and afterwards resumed payments. The wide-spread mischief resulting from such a state of things has led to the devising of various complicated schemes for insuring the stability and prudent management of banks; but as they all involve regulations which it is impossible to enforce, they are practically worse than useless. In Massachusetts, for example, it is provided that no bank for the issue of notes can go into operation in any way, until at least half its capital stock be paid in gold and silver into the bank, and be actually existing in its coffers, and seen in them by inspectors appointed for that purpose; and the cashier of every bank is bound to make specific returns once a year of its debts and assets, on being required to do so by the secretary of state. But our readers need hardly be told, that these elaborately contrived regulations are really good for nothing, unless it be to afford an easy mode of cheating and defrauding the public. Instances have occurred of banks having borrowed an amount of dollars equal to half their capital, for *a single day*, and of such dollars having been examined by the inspectors appointed for that purpose, and reported by them, and sworn by a majority of the directors to be the first instalment paid by the stockholders of the bank, and intended to remain in it.[1] We do not of course imagine that such disgraceful instances can be of common occurrence; but what is to be thought of a system which permits a company for the issue of paper-money, founded on such an abominable fraud, to enter on business, with a sort of public attestation of its respectability? The publicity, too, to which the American banks are subject, is injurious rather than otherwise. Those who are so disposed may easily manufacture such returns as they think most suitable to their views; and the more respectable banks endeavour, for a month or two previously to the period when they have to make their returns, to increase the amount of bullion in their coffers, by temporary loans, and all manner of devices. The whole system is, in fact, bottomed on the most vicious principles. But it is unnecessary, after what occurred in 1836 and 1837, to insist further upon the gross and glaring defects of American banking. Perhaps no instance is to be found in the history of commerce, of such a wanton over-issue of paper as took place in the United States in 1835 and 1836. The result is known to every body; the revulsion to which this over-issue necessarily led having, in May 1837, compelled every bank in the Union, without, we believe, a single exception, to stop payments.

Owing to the privilege claimed by the different states, and exercised without interruption from the Revolution downwards, it is, we fear, impossible to effect the suppression of local paper in America, or to establish a paper currency which should at all times vary in amount and value, as if it were metallic. But the states have it in their power to do that which is next best; they may compel all banks which issue notes to give security for their issues. This, though it would not prevent destructive oscillations in the amount and value of the currency, would, at all events, prevent those ruinous and ever-recurring stoppages and bankruptcies of the issuers of paper-money, that render the American banking system one of the severest scourges to which any people was ever subjected. Common sense and experience alike demonstrate the inefficacy of all the regulations enacted by the American legislature to prevent the abuse of banking. It is in vain for them to lay it down that the issues shall never exceed a certain proportion of the capital of the bank, and so forth. Such regulations are all very well, provided the banks choose to respect them; but there are no means whatever of insuring their observance; and their only effect is to make the public look for protection and security to what is altogether impotent and worthless for any good purpose. The suppression of local issues is indispensable in order to make a paper currency what it ought to be. If, however, this be impossible in America, there is nothing left but to take security from the issuers of notes. All schemes for the improvement of banks, by making regulations as to the proportion of their issues, and advances to their bullion, capital, &c. are downright delusion and quackery. (c. c.)

Table showing the Number and Capital of the various Banks existing in the United States at the undermentioned periods.

(See Letter of the Secretary of the Treasury, 4th of January 1837.)

STATES.	1st January 1811.		1st January 1820.		1st January 1830.		1st January 1836.			1st December 1836.		
	No. of Banks.	Capital estimated.	No of Banks.	Capital estimated.	No. of Banks	Capital estimated.	No. of Banks.	No. of Branches.	Capital paid in.	No. of Banks.	No. of Branches.	Capital authorized.
		Dollars.		Dollars.		Dollars.			Dollars.			Dollars.
Maine	6	1,250,000	15	1,654,900	18	2,050,000	36	0	3,935,000	59	0	5,535,000
New Hampshire	8	815,250	10	1,005,276	18	1,791,670	26	0	2,663,308	23	0	2,663,308
Vermont	0	...	1	44,955	10	432,625	19	0	1,125,624	20	0	2,200,000
Massachusetts	15	6,292,144	28	10,485,700	66	20,420,000	105	0	30,410,000	138	0	40,830,000
Rhode Island	13	1,917,000	30	2,982,026	47	6,118,397	61	0	8,750,581	64	0	9,100,581
Connecticut	5	1,933,000	8	3,689,337	13	4,485,177	31	3	8,519,368	31	3	8,519,368
New York	8	7,522,760	33	18,988,774	37	20,083,353	86	2	31,281,461	98	2	37,303,460
Pennsylvania	4	6,153,150	36	14,681,780	33	14,610,333	44	0	18,858,482	50	0	59,658,482
New Jersey	3	739,740	14	2,130,949	18	2,017,009	25	0	3,970,090	26	0	7,575,000
Delaware	0	...	6	974,906	5	830,000	4	4	817,775	4	4	1,197,775
Maryland	6	4,895,202	14	6,708,131	13	6,250,495	18	2	8,203,575	28	3	29,175,000
West of Columbia	4	2,341,395	13	5,525,319	9	3,875,794	7	0	2,339,738	7	0	3,500,000
Virginia	1	1,500,000	4	5,212,192	4	5,571,100	5	18	6,511,300	4	18	6,711,300
North Carolina	3	1,576,600	3	2,964,887	3	3,195,000	3	4	1,769,231	3	4	2,600,000
South Carolina	4	3,475,000	5	4,475,000	5	4,631,000	8	2	7,936,318	8	2	10,356,318
Georgia	1	210,000	4	3,401,510	9	4,203,029	14	11	8,209,967	14	11	8,209,967
Florida	0	...	0	...	1	75,000	5	0	1,484,386	9	0	9,800,000
Alabama	0	...	3	469,112	2	643,503	2	4	6,558,969	3	4	14,458,969
Louisiana	1	754,000	4	2,597,420	4	5,665,980	14	31	34,065,284	15	49	54,000,000
Mississippi	0	...	1	900,000	1	950,000	5	8	8,764,550	11	12	21,400,000
Tennessee	1	100,000	8	2,119,782	1	737,817	3	4	4,546,285	3	4	5,600,000
Kentucky	1	240,460	42	8,807,431	0	...	4	10	5,116,400	4	10	9,246,640
Arkansas	0	...	0	...	0	...	0	0	...	2	0	3,500,000
Missouri	0	...	1	250,000	0	...	0	1	...	0	0	...
Illinois	0	...	2	140,910	0	...	2	5	478,220	2	6	2,800,000
Indiana	0	...	2	202,857	0	...	1	10	1,279,857	1	10	1,980,000
Ohio	4	895,000	20	1,797,463	11	1,454,386	31	1	8,369,744	32	1	12,900,000
Michigan	0	...	0	...	1	100,000	7	3	909,779	17	3	7,500,000
Wisconsin Territory	0	...	0	...	0	...	0	0	...	1	0	100,000
States' Banks	88	42,610,601	307	102,210,611	329	110,102,268	566	123	216,875,292	677	146	378,421,168
Union States Bank.	1	10,000,000	1	35,000,000	1	35,000,000	1	23	35,000,000	0	0	...
Total...	89	52,610,601	308	137,210,611	330	145,192,268	567	146	251,875,292	677	146	378,421,168

N.B.—Some of the returns of capital in the last column are incomplete.

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[1] Gouge's Paper-Money and Banking in the United States, part ii. p. 157.

PAPIER MACHÉ. This is a substance made of cuttings of white or brown paper, boiled in water, and beaten in a mortar, till they are reduced to a kind of paste, and then boiled with a solution of gumarabic or of size, to give tenacity to the paste, which is afterwards formed into different articles, by pressing it into oiled moulds. When dry, the work is done over with a mixture of size and lamp-black, and afterwards varnished. The black varnish for these articles is prepared as follows. Some colophony, or turpentine boiled down till it becomes black and friable, is melted in a glazed earthen vessel, and thrice as much amber in fine powder is sprinkled in by degrees, with the addition now and then of a little spirit or oil of turpentine. When the amber is melted, sprinkle in the same quantity of sarcocolla, continuing to stir them, and to add more spirit of turpentine, until the whole becomes fluid; then strain it out clear through a coarse hair bag, pressing it gently between hot boards. This varnish, mixed with ivory-black in fine powder, is applied, in a hot room, on the dried paper paste, which is then set in a gently heated oven, next day in a hotter oven, and the third day in a very hot one, and allowed to remain each time till the oven grows cold. The paste thus varnished is hard, durable, glossy, and is not affected by liquor, however hot.

PAPHLAGONIA, in *Ancient Geography*, a country of Asia Minor, beginning at Parthenius, a river of Bithynia, on the west, extending in length to the Halys on the east, and having the Euxine on the north, and Galatia on the south.

PAPHOS, in *Ancient Geography*, two adjoining islands on the western side of the island of Cyprus, the one called *Palæa Paphos*, and the other *Nea Paphos*; and when Paphos is mentioned without an adjunct, this latter is always understood.

PAPIAS, bishop of Hierapolis, a city of Phrygia, was the disciple of St John the Evangelist, and the companion of Polycarp. He composed a work in five books, entitled Expositions of the Discourses of our Lord, of which there are only some fragments now remaining. It was Papias who introduced the opinion of the Millenarians.

PAPINIAN, a celebrated Roman lawyer of the third century. The Emperor Severus had so high an opinion of his worth that he recommended his sons Caracalla and Geta to the care of the jurisconsult. Caracalla having murdered his brother, ordered Papinian to compose a discourse excusing this murder to the senate and people; but the lawyer refused to undertake the disgraceful task assigned him, and the brutal emperor, enraged at his refusal, ordered him to be beheaded, and his body dragged through the streets of Rome. Papinian wrote several treatises on professional subjects.

PAPISTS. See POPE and ROMAN CATHOLICS.

PAPPAL, a district of Borneo, on the north-east coast, the limits of which, on the north, are Sampanmangio and Keemanees river, in latitude 5. 30. north. The productions of this coast are, in general, sago, rice, betel-nut, cocoa-nut oil, camphor, wax, pepper, and coarse cinnamon. It is well watered, and has the convenience of many rivers that are navigable for boats, and some for larger vessels.

PAPPENHEIM, a city of the kingdom of Bavaria, in the circle of the Rezat, which, with a district around it of seventy-seven square miles, inhabited by 7500 persons, forms a bailiwick, belonging to the mediatized count of that name, who, besides this, has other estates within the Prussian dominions. The city is situated upon the river Altmuhl, and contains the palace, two Lutheran churches, and 220 houses, with 1960 inhabitants.

PAPPUS, an eminent philosopher of Alexandria, said by Suidas to have flourished under the Emperor Theodosius the Great, who reigned from 379 to 395. His writings prove him to have been a consummate mathematician. Many of them, however, are lost; and those which remain continued long in manuscript, detached parts only having been occasionally published, until Carolus Manolessius published his remains entire at Bologna in 1660, folio.

PAPUA, or NEW GUINEA, a very large island, or, as some suppose, a cluster of islands, the coast having never been explored, and extending from the south end of Gilolo and the north coast of Ceram, in a south-west direction, about 1200 miles. It is indented by very deep bays, so that it resembles a chain of peninsulas; and it is because none of these inlets have been explored that it is uncertain whether it be all one island or a chain of islands. It is separated from the neighbouring island of New Holland by a narrow strait, discovered by Captain Flinders, in the Investigator. Viewed from the shore, Papua rises gradually into hills of considerable elevation; but there are no mountains of any great altitude. The country produces palm trees, and timber of a large size; the cocoa-nut, and the two species of the bread-fruit tree; also pine-apples and plantains, nutmeg trees in a wild state, and spice. The woods abound with wild hogs, which are hunted and killed by the natives with spears, and bows and arrows. The indigenous inhabitants of the interior practise gardening, and some sort of agriculture, and supply the inhabitants on the coast with food, in exchange for axes, knives, and other sorts of coarse cutlery. The Malays and Chinese chiefly carry on this traffic, supplying the natives also with blue and red cloths, and carrying back in return bark, slaves, ambergris, sea-slug, tortoise-shell, small pearls, and black and red loories, birds of paradise, and other birds, stuffed, in which art the Papuans are very dexterous. The island has chiefly been seen by navigators from the sea. Captain Forrest. who landed on the north-west coast, observed the structure of the Papuan dwellings, which was extremely singular, being built upon posts fixed several yards below the water-mark, and a long stage supported by posts communicating with the land just at high-water mark. The tenement contains many families, who live in cabins on each side of a common hall that runs through the middle of it, and has two doors, one opening to the land and the other to the water, for the purpose of facilitating the escape of the inmates when they are attacked by their enemies. The greater part of the inhabitants continue in their original state of barbarity and nakedness, devoid of any fixed homes, and subsisting on the precarious produce of the chase or of the forests. They are engaged in continual wars with their neighbours; and about April and March they assemble in great numbers, and make war on Gilolo, Ceram, Amboyna, and Ambloo. The British have had as yet but little intercourse with these savages; and their ferocious habits do not encourage any very close alliance. In 1791 they contrived to decoy the surgeon of the Panther, a Bombay cruiser, into their boats, where he was murdered; after which they had the audacity to make an attempt on the ship, discharging on it a shower of arrows, and wounding several of the crew. They were, however, soon dispersed by a discharge from the guns and small arms.

PAPYRUS, the reed from which was prepared the far-famed paper of Egypt.

Before entering on a description of the papyrus, it may be right to say a word or two as to the opinion generally received in Europe concerning the disappearance of this plant. Supposing the circumstance possible, the date of it must be fixed at no distant period; for it is not more than two centuries since Guilandin and Prosper Alpin observed the papyrus on the banks of the Nile. Guilandin observed the inhabitants of the country eating the inferior and succulent part of the stem, in the manner of the ancients; a fact which shows that it must have been the papyrus. This, and the practices related by Prosper Alpin, are sufficient to convince us that the plant is not wholly useless, although it is not now employed in the fabrication of paper. The alteration in the soil of Egypt, and the methods of agriculture, have in all probability rendered the plant less common; but causes altogether local could not occasion the destruction of the papyrus, especially as its residence in the marshes would prevent their operation. It is needless, however, to reason from probabilities or analogy. Mr Bruce not only saw the papyrus growing both in Egypt and Abyssinia, but actually made paper of it in the same manner as that in which it was made by the ancients. He tells us, likewise, that, so far from any part of it being useless, the whole plant is at this day used in Abyssinia for making boats, a piece of the acacia tree being put into the bottom to serve as a keel. That such were the boats of ancient Egypt, we know from the testimony of Pliny, who informs us that the plants were first sewed together, and then gathered up at stem and stern, and tied fast to the keel: *Conseritur bibula Memphitis cymba papyro.*

The papyrus, says Pliny, grows in the marshes of Egypt, or in the stagnant places of the Nile, formed by the overflowing of that river, provided they are not beyond the depth of two cubits. Its roots are tortuous, and in thickness about four or five inches; and its stem is triangular, rising to the height of ten cubits. Prosper Alpin states it as growing about six or seven cubits above the water; the stem tapering from the bottom, and terminating in a point. Theophrastus adds, that the papyrus carries a top or plume of small hairs, which is the thyrsus of Pliny. Guilandin informs us, that its roots throw to the right and left a great number of small fibres, which support the plant against the violence of the wind, and against the waters of the Nile. According to him, the leaves of the plant are obtuse, and resemble the *typha* of the marshes. Mr Bruce, on the other hand, assures us that it never could have existed in the Nile. Its head, says he, is far too heavy; and in a plain country the wind must have had too violent a hold of it. The stalk is small and feeble, and withal too tall; the root is also too short and slender to stay it against the violent pressure of the wind and current; and therefore it could never have been a plant growing in the river Nile itself, or in any very deep or rapid river, but only in the calishes or places where the Nile had overflowed and was stagnant.

The Egyptians made of this plant paper fit for writing (see PAPER), which they called βιβλος, or *philuria*, and also χαρτης, whence the Latin *charta*; for in general the word *charta* is used to signify the paper of Egypt.

The papyrus was produced in so great quantities on the banks of the Nile, that Cassiodorus compares it to a forest. There, says he, rises to the view, this forest without branches, this thicket without leaves, this harvest of the waters, this ornament of the marshes. Prosper Alpin is the first who gives us a plate of the papyrus, which corresponds in some degree with the description of the plant mentioned by Theophrastus; but by far the best drawing of it is that given by Bruce.

The ancient botanists placed the papyrus amongst the gramineous plants or dog-grass; ignorant of the particular kind to which it belonged, they were contented to specify it under the name of *papyrus*, of which there were two kinds, namely, that of Egypt, and that of Sicily. The moderns have endeavoured to show that these two plants are one and the same species of cyperus; and it is under this genus that they are found in the catalogues and descriptions of plants published since the edition of Morrison's work, where the papyrus is called *Cyperus Niloticus Syriacus maximus papyraceus.*

It is impossible to determine whether the papyrus of Sicily was used in any way by the Romans. In Italy it is called *papero*, and, according to Cesalpin, *pipero*. This papyrus of Sicily was cultivated in a garden at Pisa; and if we can depend on the authority of Cesalpin, who himself examined the plant, it is different from the papyrus of Egypt. The papyrus, says he, which is commonly called *pipero* in Sicily, has a longer and thicker stem than the plant cyperus. It rises sometimes to the height of four cubits; the angles are obtuse, and the stem at the base is surrounded with leaves growing from the root; and there are no leaves on the stem even when the plant is at the greatest perfection; but it carries at the top a large plume, which resembles a great tuft of dishevelled hairs. This is composed of a great number of triangular pedicles, in the form of reeds, at the extremity of which are placed the flowers, between two small leaves of a reddish colour like the cyperus. The roots are woody, about the thickness of reeds, jointed, and throw out a great number of branches, which extend themselves in an oblique direction. These are scented somewhat like the cyperus, but their colour is a lighter brown: from the lower part issue many small fibres, and from the higher a number of stems shoot up, which, in proportion as they are tender, contain a sweet juice.

The plume of the papyrus of Sicily is a tuft or assemblage of a great number of long slender pedicles, which grow from the same point of division, are disposed in the manner of a parasol, and carry at the top three long and narrow leaves, from which issue other pedicles, shorter than the former, and terminating in several knots of flowers. Micheli (*Nova Plantarum Genera*, Florence, 1728) has given an engraving of one of the long pedicles in its natural length. It is surrounded at the base with a case of about one inch and a half in height; and towards the extremity it carries three long and narrow leaves, and four pedicles, to which are fixed the knots of flowers. Every pedicle has also a small case surrounding its base. In short, the papyrus of Sicily is well known to botanists. It were to be wished that we had as particular a description of the papyrus of Egypt. It may be observed, however, that these two plants have a near affinity to one another; that they are confounded together by many authors; and that, according to Theophrastus, the *sari* and the *papyrus nilotica* have a decided character of resemblance, differing only in this, that the papyrus sends forth thick and tall stems, which being divided into slender plates, are fit for the fabrication of paper, whilst the *sari* has small stems, considerably shorter, and altogether useless for any kind of paper.

The papyrus, which anciently served to make paper, must not be confounded with the papyrus of Sicily, which is also found in Calabria. According to Strabo, the papyrus was not to be found anywhere except in Egypt and in India. The greater part of botanists have believed that the Sicilian plant is the same with the sari of Theophrastus; but others have alleged that the papyrus of Egypt and the sari were the same plant in two different stages of its existence, or considered with respect to the greater or less height; which, according to them, might depend upon the qualities of the soil, the difference of the climate, or other accidental causes. In proof of this, it is maintained, that there is an essential difference between the papyrus growing in the waters and the same plant growing on the banks of rivers and in marshes. The first of these has thick and tall stems, and a plume in the form of a tuft of hair very long and slender, and without any seed. The second differs from the first in all these particulars; it has a shorter and more slender stem, its plume is loaded with flowers, and consequently it produces seed. In whatever way we consider these facts, it is sufficient for us to know, that the difference between the papyrus and the sari neither depends on climate, nor soil, nor situation. The plants whose difference depended on these circumstances both grew in Egypt, and were both employed in the manufacture of paper. But it is an established fact, that the sari cannot be employed for this purpose.

Finally, the papyrus of Sicily began to be known by botanists in the years 1570, 1572, and 1583, at which periods the works of Lobel, of Guilandin, and of Cesalpin, first appeared. The ancients had no manner of knowledge of this plant, and Pliny makes no mention of it in his Natural History; from which it is evident that it was used neither in Rome nor in Sicily. If he had seen this plant, he must have been struck with its resemblance to the papyrus and the sari, as these were described by Theophrastus; and since he gives a particular description of the latter, he would most naturally have hinted at their conformity to the Sicilian papyrus, had such actually been the case.

PAR, in *Commerce*, signifies any two things which are equal in value. See EXCHANGE.

PARA, a province of Brazil, in South America, of immense extent, and of such surprising fertility that it is characterized as at once the paradise of the Indies and of Brazil. It is a region of endless luxuriance, one where every rood of ground would maintain its man; and sufficiently capacious to receive all the redundant population of Europe; for the dwellings of man are scattered over it so thinly that they have been compared to islands in a vast ocean. It is situated to the south and south-east of Guiana, being separated from it by the river Amazons. The river Madera, or Madeira, the great tributary of the Amazons, separates it on the north-west and west from the province of Solimoens and the territory of Peru. A line drawn nearly parallel with the ninth degree of south latitude separates it from the province of Matto Grosso on the south; Maranham bounds it on the east; and a considerable part of its northern limits is washed by the Atlantic Ocean. Its greatest length, from the Atlantic to the borders of Peru, is above fourteen hundred miles; at the broadest it is more than five hundred miles across, but it narrows towards either extremity, lying east and west. This vast tract of country is, to a considerable extent, a *terra incognita*, and it is supposed that at least two thirds of it are yet in possession of the aboriginal Indians. Cazal divides it into four large districts, viz. Para proper, a flat and wooded country, extending west of Maranham two hundred miles to the river Toccantines or Tocannos, which in this quarter traverses its whole extent from south to north; Xingutania, lying between the Toccantines and the river Xingu or Ghingu, which falls into the Amazons, near its mouth; Tapajonia, extending from the latter river to the Tapajos, which joins the Amazons about two hundred and twenty miles higher up than the Xingu; and Mundrucania, so designated from the Mundrucu Indians, who inhabit it, extending from the Tapajos to the Madera, which unites with the Amazons about the same distance above the Tapajos that the latter river is above the confluence of the Xingu. Indeed, in examining a good map of the country, nothing appears more striking than the manner in which the province of Para is divided into four portions by the rivers above named, all nearly of equal size, with the exception of Para proper, which is much smaller than the others. Of these rivers, the Amazons and the Madera have already been described in this work; and they constitute the leading hydrographical features of the country. The Toccantines is also a very large stream, in one part expanding to ten miles in breadth; and it is beautified with numerous islands. The Xingu and Tapajos are likewise considerable streams, originating in a cordillera of moderate elevation, which runs from north to south in the province of Matto Grosso. The upper courses of these rivers have never been explored, and the country which lies between them, and also between the Tapajos and Madera, where it joins with Matto Grosso, is consequently known only by the reports of the Indians. There are a number of other rivers, but none which requires specific mention, except the Annapu, which falls into the estuary of the Amazons between the rivers Toccantines and Xingu. Several islands lie at the mouth of the Amazons, one of which, called Majora, is a hundred miles in circumference, and so situated as to divide the river into two unequal branches. The island of Majora is a low, flat, alluvial formation, covered with brushwood and grass, and abounding in cattle and horses, with which it supplies Para. It is overrun with alligators, snakes, and wild beasts; and during the rainy season it is much flooded, and rendered very unhealthy when the waters have quitted it, and the sun has begun to exhale the malaria.

The geology of Para presents but little variety or novelty, and is precisely similar to that of Maranham. The soil upon which the city of Para stands is composed of clay and sand. The beds of clay are very extensive, and frequently thirty or forty feet in depth. There is scarcely any rock, and that only in particular and isolated masses; it is a coarse dark iron sandstone, with numerous particles of quartz imbedded in it. This is the only stone, and it is used as a building material. This species of sandstone, with fragments of white quartz, is observable at Maranham, and is the predominating formation at St Paul's, a little to the southward of Rio. The beds of clay at Para are of various qualities, some being admirably adapted for bricks, tiles, and coarse pottery; whilst others, again, are very fine, and capable of forming utensils which might vie in beauty with the celebrated Wedgewood ware. Beds of yellow ochre are abundant, and it is much in use for painting the houses externally. Limestone is imported from Portugal, granite from Rio, and slabs and sills from Europe. A gold mine is said to have been found in a mountainous hill on the coast near Selina No organic remains have as yet been discovered in these parts. The larger portion of the soil of Para is of extraordinary fertility, as will be seen by the account of the vegetable productions, remarkable alike for their variety and luxuriance. Situated immediately beneath the equator, the climate is hot and sultry; the thermometer averaging throughout the day from 84° to 89° in the shade. At night it occasionally falls as low as 75°, with very heavy and copious dews, particularly upon the river, drenching such boats as may be upon it, as if a shower of rain had descended. The river water is tepid, generally about 84°. As the air cools in the evening, it chills the surface of the water, and in doing so a humid vapour is emitted. There is no difference of temperature throughout the year, the mean degree of heat being 84°. There are two seasons, the wet and the dry. The rainy season commences in the latter part of December, and continues until July, raining more or less every day, without intermission, for many hours. The air continues sultry and oppressive, with light variable winds, and occasional squalls from various points of the compass, accompanied by thunder and lightning of the most appalling description, whilst the rain at the same time descends in torrents. The thunder-storms take place most frequently in the afternoon, about two or three o'clock; and the same is observable at Rio and other places. It generally begins to rain about eleven o'clock in the forenoon, and continues until nine or ten at night. The country is flooded in many parts during this season, and vessels are often detained several weeks, not being able to take on board their cargoes. The dry season at Para occupies the remaining portion of the year, from July to December. But even during this period rain frequently falls, and thunder-storms occur in the afternoon. This is also the peculiar season of winds, which blow fresh from the north-east during the day, with a light breeze only in the evening. Lightning is frequent in the horizon every night. Of course the days and nights in this "region of the sun" are nearly of equal length throughout the year. For a country situated within the torrid zone, Para cannot be considered as unhealthy, although it was formerly reckoned so. But since the woods were thinned, and cattle were introduced, a material improvement has taken place. It is exempted from endemic diseases; but intermittent fevers or agues attack those who have newly arrived in the country, and they become more common as the river is ascended. Those employed in the gathering of sarsaparilla are very frequently attacked with fever, and numbers of the natives die of it. Dysentery, tetanus, and some other diseases, common to various parts of Brazil, prevail in Para. In 1825, the small-pox is said to have carried off five thousand persons in the capital.

This province is unusually rich in vegetable productions, particularly such as are called, *par excellence*, botanical. There is an inexhaustible supply of timber of the very best quality, and almost of every variety, so that there is abundance of fuel. The palms are amongst the most conspicuous and useful products of the vegetable kingdom. They afford the inhabitants food, drink, and even raiment; for the pith of some of these species of trees produces an edible substance resembling sago, the pericarp of others yields a pleasant beverage, and the leaves afford a covering for houses, as well as materials for making hats and baskets. Some furnish them with oil; and canoes and boats are hollowed out of the trunks of others. The palms are of various species; one, called the areca, reaches a hundred and thirty feet in height. Indeed there is to be found here timber for every purpose for which man can require it, from the soft cork-wood of the *ochroma sayopus*, to the dense hard iron wood. There is the *cedrela odorata*, or soft cedar wood, very handsomely veined; the white cedar or *bignonia leucoxylon*, and an abundance of other bignonias; the balsam copaiva tree, which affords good timber, besides its medicinal product; ornamental woods of every hue and grain, including rose-wood, satin-wood, yellow wood, ebony, and others; the *bertholletia excelsa*, a lofty spreading tree, producing a woody capsule three inches in diameter, so heavy, hard, and solid that it requires a powerful blow of a sledge-hammer to break it (the bark of this tree, when beaten into flakes, is used in place of oakum or hemp); the *lecythis ollaris*, or pot-tree (so called from the seed-vessel resembling a rusty iron pot with a lid), the nuts of which are esteemed as of a very superior quality, and are sent as presents from the interior; the *carapa guareoides*, or anderaba, the seeds of which yield an oil that is put to a variety of uses, and amongst others as a lamp-oil, and for making soap; the calabash, which furnishes the natives with many utensils; excellent woods for ship-building, equal to the teak of India; and a vast variety of trees and plants which yield dye-stuffs of the finest quality. Amongst these may be mentioned arnotta, of which there are three species; indigo; crajaru, or the juice of a plant (*bignonia*), formed into cakes of a bright red. It is prepared by the Indians, and is a capital and very durable oil colour. The *amomum sylvestre* yields a blue colour. Para is exceedingly rich in oils, including turtle-oil, procured from the fat of the turtle. Turtles frequent the upper part of the river in immense numbers; and no less than six thousand jars of their oil, each containing seven gallons, are annually received at Para. Besides these, may be mentioned the azeite mammona, or castor oil, for lamps, and common lamp-oil; the unctuous substance of cacao, which is used in the manufacture of soap; a fine sweet oil resembling that of the olive, obtained from the patacia, a species of palm; the bacova, a species of palm oil; the common cocoa-nut oil; and that of the anderaba, already mentioned. These oils can be procured in the greatest abundance, at a very cheap rate, and may be rendered an object of considerable commercial importance. Amongst the medicinal plants and drugs are sarsaparilla, balsam copaiva, tonquin beans, procured in vast quantities, and which yield, by distillation with spirits or with water, an odorous essential oil; arnotta vanilla, which perfumes the woods, and creeps up the trees like a large and elegantly-leaved ivy; gum copal of a spurious quality; gum caju, or the gum of the cashew apple; the pod of the *cassia fistularis*, and the leaves of several of the cassias, which are as good as senna; the *portlandia hexandria*, which is an emetic, a cathartic, a febrifuge, and a tonic; the *mirabilis jalapa*, or the jalap of the country, very common in Para; besides many others, which it is unnecessary to enumerate. Not a few of the trees of this province yield a milky juice, the fig-trees in particular, and they are very numerous. One of the most remarkable of these is the *vaccodendron lactifera*, or milk-bearing cow-tree as it has been called, from its extraordinary property of yielding milk, similar, it is said, to that of a cow. The tree is one of the loftiest in the forest, being above a hundred feet in height. The fluid which it yields appears to bear the nearest resemblance to animal milk of any vegetable product. It is a rich white bland fluid, without odour, and of the taste and flavour of common milk, as a substitute for which it is extensively used. Amongst the useful and curious products of the province, the *siphonia elastica* or cahuchuc requires particular mention. It is the tree which produces the well-known elastic gum or India rubber, and is amongst the largest of the forest. It abounds to such an extent as to form one of the staple articles of commerce, and Para is the great emporium for supplying Europe with this article. Very strong and durable shoes, and other articles of wearing apparel, are manufactured from it. Amongst the spices and aromatics, this province produces turmeric, ginger, black pepper, cayenne, native nutmeg, *laurus cinnamomoides*, clove bark (having precisely the flavour of cloves, and used as such), some aromatic amomums, several species of pepper, piper amalayo, and ginger pepper. There are also laurels, cinnamon, cloves, and allspice cultivated for sale; and the tobacco raised is reported to be the genuine Orinoco.

Para yields great abundance of fruits, and also of farinaceous grains and roots. Rice, Indian corn, and the favourite mandioc root, supply the inhabitants with flour and tapioca. Cocoa is plentiful, and coffee and sugar are cultivated for exportation. Amongst the fruits of the province are several varieties of the most exquisite pine-apples, remarkably large and fine oranges, limes, sweet lemons, custard apples, cherimoyas, alligator pears of an immense size, very fine quality, and forming a part of the food of the common people; the fruits of the passiflora, tamarinds, guavas, pawpaws, superb melons, plantains, and bananas, mangoes in profusion, several species of the achras, and palm drupas; the bucari, ingas, rose-apple, bread-fruit, and jacks; figs, sapodillas, abiu, macoubea, and abricot, similar in flavour to the apricot. There is a small crop of grapes three times a year. The marauta, or arrow-root genus, affords several edible roots; and, with regard to vegetables, there are abundance of cucumbers, pumpkins, lettuce, chilis, potatoes, cabbages, a variety of beans, yams of several kinds, tomatas, and the egg-apple, besides others. Without adverting to the Flora of this province, farther than stating generally that it is exceedingly beautiful and various, the foregoing account of the vegetable kingdom of Para will sufficiently show that, in the abundance, variety, and luxuriance of its products of this description, it is not surpassed by the most favoured spots upon the globe.

Para is equally prolific in wild animals, abounding in monkeys, snakes, and lizards. The vampires fly about at night in great numbers, and are exceedingly annoying; and the vampire bat, in particular, is notorious in the country for its blood-sucking powers. The guano tribe is numerous, but harmless and timid as hares; and there are numbers of tapirs and ounces. The river-banks are infested with alligators, the island of Marajo being their rendezvous. The electrical eel attains to a considerable size, and sometimes kills a horse that is wading in the streams. Such is its power, that by one stroke of its body it knocks the animal down and kills it. There is an abundant supply of fish, both from the river Amazons and from the ocean; but they do not keep well. The dorado is the most esteemed. There are two large fishes of the silurus kind, which yield isinglass; but a better sort is procured from the gurujuda, a fish somewhat like a sturgeon in appearance, and caught at the mouth of the river. The pereiba is a very large fish, from five to six feet in length, and of a shark-like aspect. The pirarucoa is likewise a very large fish, which the inhabitants salt; and there are various kinds of small fish, which it is unnecessary to enumerate. The birds of these regions are well known, being famous for their beauty and splendour; and insects are so multitudinous that, according to a writer who has visited the country, "the ants alone would be the labour of a person's life to detail; in every fruit, on every flower, there is almost a peculiar ant."[1] Fire-flies sparkle beautifully at night amongst the trees and bushes, flashing their meteoric wings, and then vanishing in a moment. Some of the spiders are extremely large and venomous; and Para is noted for snakes, amongst which is the gigantic boa-constrictor, that kills an ox and immediately gorges the animal.

Capital.

The city of Para stands on a low part of the right bank of the eastern branch of the river Para, about fifty miles from its mouth. As seen from vessels in the river, it presents nothing particularly attractive or conspicuous except its numerous churches. No lofty ranges of buildings are to be seen in this city of the western world; and, being environed by wood and the waters of the river, and built on somewhat low ground, it has altogether a humble appearance. It extends about two thirds of a mile along the Para, and is about half a mile in breadth; the highest point of ground, that on which the church of St Anne is situated, being about seventy feet above the surface of the river. Directly opposite to it, and about two miles distant, is the large island of Oncas, with several smaller ones lower down the river. Rather more than a league below the city there is an insulated rock, on which a fort called Serra is built, and to which all vessels inward or outward bound are obliged to send a boat with papers before they are allowed to proceed to or depart from the city. Somewhat less than a league above the city is the mouth of the river Guama, up which passengers to Maranham are said occasionally to proceed in an easterly direction, and, crossing a narrow neck of land, embark in boats on the sea, keeping close in along the coast. It is probably on account of the facility which this and other rivers, particularly the Toccantines, afford for a communication with the interior of Brazil, that the present site of Para was chosen. Between the mouth of the river Guama and the city there is the naval arsenal, at which large vessels are built. The city is protected by two forts, both placed on steep and rocky but not elevated points. The streets of Para are laid out at right angles to each other, but they are not remarkable for their breadth, and only some of them are paved. The houses in general are about two stories high, and well built, having latticed blinds for windows, which adds to the sombre appearance of the city Para has little of that bustle of business observable in most commercial towns, but is dull, noiseless, and cheerless. The principal building in Para is the palace, a large square, two stories in height, having an open balcony at the second story, ornamented with large wooden figures at the outer part, and palm-trees between the windows. Several of the government offices are in the palace, and it is the abode of the president. Internally it is well but not gaudily fitted up; and altogether it is a handsome and commodious building, every way worthy of the purpose to which it is appropriated. On the north, east, and west sides the ground is open, and there the troops were wont to be paraded every morning. Adjoining the palace are the walls and several arches of what was intended for a theatre; but although the design was good, the whole has proved a failure. There are a cathedral and eight churches; and there either are or were four or five convents. The cathedral is built in the form of a Latin cross; and its structure and decorations, without being gaudy, have a pleasing effect. The interior is neat, and is of sufficient size to accommodate a large audience. The bishop's palace is in the cathedral square, and stands opposite to that building. It is a large and plain but respectable edifice; and appended to it is a church or chapel for the domestic service of the bishop and his establishment. In the same square there is a comfortable hospital. The remaining part of it is filled up with dwelling-houses. In the middle of the city is the church of St Anne; close to the water is the church of Los Mercez, and adjoining to it are the custom-house and the prison. These three form the most conspicuous range of buildings in the city, but they are nevertheless by no means remarkable. The custom-house is large, well built, and apparently commodious. It has a distinct quay, with a broad flight of wooden stairs leading to it; and immediately opposite to it stands one of the forts.

The streets of Para have little or nothing that is attractive about them. The shops and warehouses are numerous, and are tolerably well supplied with merchandise; but there is a deficiency of taste and elegance in their arrangement. The markets are held close by the water-side, near the church of Mercez, where women with vegetables and fruit congregate for the most part of the day; but butcher-meat is not to be obtained after ten in the forenoon, a very salutary regulation, on account of the great heat of the place. Cattle and horses are brought from Marajo and some of the neighbouring islands, where they run wild, but belong to individuals, some of whom are the proprietors of whole islands, and all the cattle upon them. The horses are not large nor powerful; and in the wild state they are valued at about five dollars each. They are occasionally exported to the islands of the West Indies. Although Para possesses few attractions as a city, the environs contain numerous beautiful shady walks and cool retreats. There is one public walk in the city, much resorted to in the evening, for the delightful promenade which it affords. The others are principally formed by rows of lofty silk-cotton trees, which bear no little resemblance to the elegant horse-chestnut of Britain. The country in the immediate vicinity of Para is very beautiful, and the outlets to it are abundant. In the suburbs of the city there are several elegant little villas, with extensive gardens attached to them, rich in all the varieties of tropical produce. The road to the Nazaré church, distant about a mile from the city, is a favourite resort of the people of Para. The church, which is built on a small scale, like that of a village, is simple and neat, and most romantically situated on the skirts of a wood, with a small open area in front. Here, in the month of October, a scene of grand festivity takes place, called the fair of St Nazaré, over which the clergy preside, and it is attended by every inhabitant of Para. Frolic and feasting, the usual business of fairs, with the general custom of gambling, continues for a fortnight, and the scene closes with high mass, performed in the most imposing style. Para is lamentably deficient in public institutions for education. The whole town can only boast of one school, which is under the direction of the clergy. There is not, it is said, a bookseller's shop in Para; so that gross ignorance is the rule, not the exception. There is indeed a weekly gazette published, but it is chiefly as a channel through which the edicts of government are circulated. The laws are bad, and they are also badly administered; indeed justice is so tardy, that criminals may sometimes lie in prison till they rot, before being brought to trial. Para stands in longitude 48. 39. 45. west from Greenwich, and latitude 1. 28. south.

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[1] Narrative of a Voyage to the Southern Atlantic Ocean during the years 1828, 1829, and 1830; extracted from the private journal of W. H. B. Webster, surgeon of the vessel (vol. ii. p. 363). For further particulars regarding the vegetables and animals of Para, the reader is referred to this work, from which the account in the text is chiefly taken.

Notwithstanding the natural riches and the superabundant advantages of Para, it is a very poor city, and receives a subsidiary stipend from the neighbouring province of Maranham, amounting to L.8000 annually, to defray the expenses of its government. In consideration of this gratuity, Para receives the goods imported into Maranham duty free, and likewise defrays the expenses of the packets and men of war on the station. The currency of the province is a good criterion of its general poverty. Copper is the only circulating medium, and even that is of the basest description. Besides, it is, or at least was a few years ago, liable to be called up by the government at pleasure, and restamped, by which operation it became of twice its former value. "It would appear," says Mr Webster, "that this province is the very sink of the empire in respect to currency, as all the base copper coin which is not passable in the other parts of the empire finds here a ready circulation. No better idea of it can be given than the fact, that what passes for one hundred pounds in copper coin, is really and intrinsically worth only eight pounds. Silver was at a premium of twenty-five per cent.; and the very sight of a dollar, when we were there, was quite a rarity. Hence the necessaries of life are cheap. House-rent is moderate, and there are no direct taxes." In mentioning the price of articles, this writer observes, that "horses are worth sixteen shillings each, and are generally fed with rice chaff. Foreign produce is by no means high at Para, the wines of Portugal and the manufactures of England being comparatively cheap." With regard to trade, he observes, "it is said that it was the miserable policy of the Marquis de Pombal, not only to keep foreigners, but the Portuguese themselves, ignorant of the value of this province; a policy which was realizing the character of the dog in the manger illustrated by the fable. He did every thing in his power to degrade and keep it in the back ground. The situation of it is well adapted for rendering it the dépôt of an extensive and lucrative trade; but the commerce, in consequence of such short-sighted policy, is extremely small, a kind of petty retail rather than any extensive or liberal trade. A merchant is obliged to buy, from time to time, small scraps and parcels; such, for instance, as a pound or two of isinglass, by which means he is long in accumulating a stock." All the produce is brought to Para in canoes, from a distance of six or seven hundred miles in the interior. Cocoa is the staple article of commerce, and it is produced in vast quantities; but being now so much depreciated in the foreign markets, it will not defray the expense of freight. There is, in fact, no demand for it, and the aroba, or thirty-two pounds of cocoa, is sometimes worth only twenty pence. Rice is very abundant, but cotton is scarce. Sarsaparilla, which is principally exported to Lisbon, and thence to London, balsam copaiva, tonquin beans, vanilla, farina, oils, and Indian rubber, are the chief articles of exportation. Those principally imported consist of flour, spermaceti candles, soap, shoes, and other goods, from the United States; cotton goods and hardware from England; and wines, vinegar, olive oil, limestone, drugs, chestnuts, and some few other articles, from Lisbon. The manufactures of Para are ladies' combs, polished with the leaf of the *curatella Americana;* good leather, made of the skins of the goats or hares of the country; coarse and bad pottery; chocolate, coarse hammocks, straw and palm hats, lace, salt-fish, and jerked beef. The Indians bring down from the interior elegant wands of beautiful feathers, called sceptros, besides superbly ornamented hammocks, feather dresses, bows and arrows, and stained calabashes. The Brazilian tribes about Para appear to be a very fine, healthy, and well-conditioned race of people. Their skin is of a good firm copper colour, without a tinge of black; they have long jetty hair, with rubicund faces and intelligent features, in which a general expression of mildness predominates. "The superiority of the Brazilians over the poor African tribes of slaves at Para," says Mr Webster, "is particularly remarkable; and the contrast is sadly against the latter. It is customary for the negro slaves to come down in groups every morning to the riverside, to purchase various articles of produce brought down from the interior by the native canoes. At this usual morning rendezvous, some bring coffee ready made for breakfast, while others bring a favourite liquor called 'wassaree,' an infusion of a small kind of palm. This beverage has the colour of port wine, and when sweetened is highly esteemed by these people. In fact, with a banana, or alligator pear, it forms the principal fare of many, while others prefer the farina of the cassada with it." The city of Para was built by the Jesuits in the year 1615, and, before the revolt of the negroes, contained about 20,000 inhabitants. The population of the entire province was estimated in 1830 at 190,000.

The only other town of any consideration in Para proper is Bragança, formerly Cayte or Cahete, and the capital of a short-lived captaincy. It is distant about twenty miles from the sea, and nearly one hundred miles east-north-east of Para. It is a port at which coasters touch on their way from Maranham to the capital, and is one of the oldest towns in the province, with a population of about 2000 inhabitants. Villa Vicoça, or Cameta, is the largest town in the whole province next to Para. It is situated on the left bank of the Toccantines, about forty miles from its mouth, and ninety miles south-west of the capital, with which it has a distinct water communication, by means of a natural canal, navigable with the tide. This place is a mart between Para and Goyaz, and contains about 6000 inhabitants. The river Toccantines here expands to ten miles in breadth, and the tide extends twenty-six leagues higher up, to the registry of Fort Alcobaça, the navigation being thus far uninterrupted by either rocks or rapids.

The colony of Para was originally an offset from that of Maranham. In the year 1615, Francisco Caldeiro sailed from St Luiz with two hundred men in three caravels, intrusted with the project of selecting an eligible situation for a settlement more immediately within the vicinity of the river Amazons, with a view to promote the navigation of that river, and to frustrate the attempts of any other nation to form settlements in this direction. The Dutch at one time had establishments upon both banks of the river, but they were expelled by the Portuguese about the year 1622. The early history of the province exhibits the same nefarious system of slave-hunting that was practised in almost all the captaincies; but it was carried on in Para with peculiar cruelty. An end, however, was at length put to the captivity of the Indians, none but negroes being permitted to be sold as slaves; and under the Jesuits the population became more numerous than that of the eastern provinces. The evil consequences of their expulsion were more perceptible here than in any other part of Brazil, says Mr Southey, "because nowhere had so many *aldeias* been established, nor had they anywhere else been in so flourishing a state." The city of Para was recently the scene of a fearful revolt of the native Indians. The cause of quarrel was the confinement of an Indian charged with having committed some offence. His brother, having vainly solicited his liberation, assembled a body of about three hundred of his countrymen, and attacked the city on the 14th of August 1835. The assault was at first unsuccessful, and the contest continued for several days without any result; but the insurgents having gradually gained possession of the most favourable positions, the inhabitants were seized by a panic, and the Indians, rushing in through the by-lanes and narrow streets, commenced an indiscriminate slaughter, at the same time sacking and pillaging the city. An expedition sent against them proved unsuccessful; but they voluntarily abandoned the city, and the imperial troops entered it on the 13th of May 1836. When Para fell into the hands of the insurgents, it was said to have contained British property to the amount of L.300,000, but after the capture of the place scarcely a vestige of it remained. (R. R. R.)

PARABLE, a fable or allegorical instruction, founded on something real or apparent in nature or history, from which a moral is drawn by comparing it with something wherein the people are more immediately concerned: such are the parables of Dives and Lazarus, of the Prodigal Son, of the Ten Virgins, and others. Dr Blair observes, that of parables, which form a part of allegory, the prophetical writings are full; and if to us they sometimes appear obscure, we must remember, that in those early times it was universally the mode throughout all the eastern nations to convey sacred truths under mysterious figures and representations.

PARACATU, a comarca of the province of Minas Geraes, in Brazil, South America. This district, which was detached from Sabara, and formed into a separate comarca in 1815, comprehends all the country lying to the westward of the river St Francisco, from the Carinhenha to the Abaité. Cazal states that the latter river is formed by two streams of the same name, one coming from the south-west, the other from the north-west, their sources being nearly one hundred miles apart. The intervening territory is a forest tract, called Matto da Corda, enclosing several campinhas, or extensive grazing lands. The principal heads of the Paracatu are the Escuro and the Prata. The latter is said to have yielded some fine diamonds, and it was customary for a strong guard of soldiers to patrol its banks. Twenty miles north of the confluence of the Paracatu, the St Francisco receives the large river Urucuya. At almost an equal distance between the mouths of these two rivers is the considerable arraial of St Româo, which carries on an extensive inland trade, especially in salt, obtained from Pilâo Arcado and its vicinity. Above the mouth of the Urucuya the St Francisco receives on its western margin a number of rivers, on most of which there is a parish or arraial, but immense tracts of country are wholly unappropriated. On the banks of the St Francisco, and to the eastward, great numbers of cattle are bred, and large herds are sent to Rio, a distance of above six hundred miles. The want of salt in these parts is a serious evil, as it is requisite for the cattle; nor will they, it is said, breed well without it. The river Abaité is distinguished by having produced the largest diamond that was ever found in America. It weighed nearly an ounce, and was accidentally discovered by three outlaws when searching for gold. This spot has since been wrought at different periods with various success; but although large diamonds have been found, their quality has been indifferent, and the works are now abandoned. Paracatu do Principe, the only town in the district, owes its origin to its mines, which were first discovered in 1744. A great number of adventurers were lured to the spot by the quantity of gold found, and the Indians were expelled from their native territory. The town, however, has very much decayed. The gold is of a good colour, but of indifferent quality, and difficult of extraction, from the want of water. Diamonds having subsequently been discovered in various parts, the working of the gold-washings is now restricted to a few leagues round the town. The town has the advantage of a healthy situation, upon an elevated plain. The houses are of taipe; the streets are paved; and, besides the church, there are four hermitages. In the neighbourhood, the vine, the orange, and the pine-apple flourish luxuriantly, and there is abundance of deer and game. The town contains above one thousand inhabitants, but of the population of the district no correct estimate can be formed.

PARACELSUS, Philippus Aureolus Theophrastus, a famous alchemist and enthusiast of the sixteenth century, was born in 1493, at Einsiedeln, a small town of the canton of Schwitz, distant some leagues from Zurich. His father, who practised medicine at Villach in Carinthia, was a near relative of George Bombast de Hohenheim, who afterwards became grand-prior of the order of Malta; so that Paracelsus was not sprung from the dregs of the people, as his sworn enemy, Erastus, pretends. His early education appears to have been neglected, and he passed a part of his youth leading the life of a strolling schoolman of that period; in other words, he wandered from country to country, predicting future events by inspecting the stars and the lines of the hand, conjuring up the dead, and repeating various operations in alchemy and magic, into which he had been initiated either by his father, or by different ecclesiastics, amongst whom he mentions the abbot Trithcim, and several German bishops. As Paracelsus everywhere shows himself ignorant of the most common and elementary parts of knowledge, it is not probable that he had ever seriously studied in the schools. He contented himself with visiting the universities of Germany, France, and Italy; and although he boasts of having been the ornament of these schools, there is no evidence of his having legitimately acquired the title of doctor, which he chose to assume. All we know is, that he laboured for a long time in the house of a certain rich man, named Sigismond Fugger de Schwatz, in order to learn from him the secret of the philosopher's stone. According to the usage of the alchemists, Paracelsus travelled into the mountains of Bohemia, Sweden, and the East, to inspect the labours of the miners, get himself initiated into the mysteries of the oriental adepts, and observe the wonders of nature, particularly the celebrated magnetic mountain. He is also said to have traversed Spain, Portugal, France, Prussia, Poland, and Transylvania, communicating not only with the physicians, but also with the old women, quacks, and magicians of these different countries. It is even believed that he extended his travels as far as Egypt and Tartary, and that he accompanied the son of the Khan of the Tartars to Constantinople, in order to learn of a Greek who resided in that capital the secret of the tincture or elixir of Trismegistus. This vagabond life naturally left Paracelsus very little time for reading; and, in fact, he has himself stated, that during the space of ten years he did not open a single book, and that all his medical library consisted of about a dozen pages. Nor did his desire of knowledge increase with his years; for an inventory made after his death shows, that the only books which he left behind him were a Bible, a Concordance, a New Testament, the Commentaries of St Jerome on the Gospels, a volume on medicine, and some seven manuscripts.

It is not known at what period he returned to Germany; but it appears that, about the age of thirty-three, several remarkable cures, which he wrought on persons of distinction, gave him such celebrity, that in 1526, he was, on the recommendation of Œcolampadius, called to fill the chair of physic and surgery in the university of Basil. Here Paracelsus commenced his career by burning publicly in the hall the works of Avicenna and Galen; assuring his auditors, that his shoe-ties knew more than these two physicians, that all the universities, and all the writers united, were less instructed than the hairs of his beard, and that he should be regarded as the sole monarch of physic. The novelty of his doctrine, the confidence with which he spoke of his success, the power to which he pretended of prolonging life, and curing the most inveterate diseases, and the use of the vulgar tongue in his discourses, attracted to Basil a crowd of credulous persons, equally indolent and enthusiastic. The prelections which he delivered on practical medicine have fortunately been preserved; they are in a mixed jargon of German and barbarous Latin, and contain nothing but a multitude of empirical remedies, indicated with the greatest pretension. So much impudence, however, far from diminishing his renown, served only to increase it, insomuch that Erasmus, who had long suffered from gravel, applied to Paracelsus; and this circumstance led to a correspondence (which has been preserved) between these two men, who enjoyed such opposite kinds of celebrity. But even at Basil people soon began to discover that the new professor was an impudent and presumptuous quack. Scarcely had a year elapsed when his prelections were deserted. As soon as the novelty wore off, his jargon was found to be incomprehensible, and his empiricism a mere cloak for ignorance. But what contributed more than any other cause to ruin his reputation was the crapulous life which he led. According to Oporin, who lived two years with him, he almost never appeared in his lecture-room without being half drunk, and seldom dictated to his secretaries except under the influence of wine. If called to visit a patient, he rarely did so without having first gorged himself with liquor. He had the custom of sleeping in his clothes, and sometimes passed whole nights in low taverns drinking with peasants, so that in the morning he had not the slightest recollection of what had passed during the night. On one occasion, however, having exceeded the ordinary license of his orgies, he assailed a magistrate with the grossest abuse; and, dreading punishment for such an outrage, found himself under the necessity of decamping from Basil, towards the end of the year 1527. He took refuge in Alsace, whither he was followed by his secretary Oporin, with all his chemical apparatus, and then resumed the same kind of strolling life which he had led in his youth.

Being thus cast loose again upon the world, he appeared at Colmar in 1528, at Nuremberg in 1529, at Saint-Gall in 1531, at Pfeffers in 1535, and at Augsburg in 1536. He then made some stay in Moravia, where he once more compromised his reputation by the loss of some distinguished patients, and was in consequence obliged to take his departure for Vienna. From that capital he passed into Hungary, and, in 1538, appeared at Villach, where he dedicated his *Chronicle* to the states of Carinthia, in gratitude for the favours which they had bestowed on his father. But his stay here appears to have been short; for, in 1540, we find him at Mindelheim, whence he proceeded to Saltzburg, the ultimate term of all his wanderings. On the 24th of September 1541 he died in the hospital of St Stephen at that place, in the forty-eighth year of his age, and in a state of abject poverty; notwithstanding he pretended to the possession of the double secret of transmuting metals, and prolonging life even to the extent of several centuries.

The life of this man forms a curious chapter in the history of self-delusion and imposture. Yet in order to judge rightly of Paracelsus, as well as of the reform which he wished to effect in medicine, it is necessary to dismiss all prejudice, and to disregard alike the hostility of Erastus and the exaggerations of Murr. It is also proper to keep in view the predominant spirit of the age in which he lived, and to remember that this epoch was famous for the reign of astrology and alchemy, the abuse of all sorts of superstitious practices, the apparition of spectres, ghosts, and hobgoblins, frequent demoniacal possessions, and the juggleries of a crowd of seers and fanatics, who, throughout all Europe, and particularly in Germany, practised on the credulity of the people. Such were the causes which prepared the way for the system of Paracelsus, and inflicted a severe blow on that of Galen. To speak in a vulgar language, to write rather for the people than for the learned, to introduce the cabbalistical art into medicine, as a substitute for that knowledge which is only acquired by study, to employ a crowd of mystical and barbarous terms, which make the greater impression on the multitude the less they are understood; such were the means of which Paracelsus availed himself, and which, but for his own indiscretion and misconduct, would most probably have been attended with triumphant success.

His philosophical and medical system is curious, even by reason of its absurdity. He takes as his primary supports religion and the sacred books. He assures us that the contemplation of the perfections of the Deity is sufficient to procure all knowledge and all wisdom; that the Holy Scriptures conduct to all kinds of truth; that the Bible furnishes a key to the theory of diseases; and that magical medicine can only be learned by the study of the Apocalypse. The man who blindly obeys the will of God, and who succeeds in identifying himself with the celestial intelligences, possesses the philosopher's stone; he can cure all diseases, and can prolong his life at pleasure, because he holds in his possession the tincture which Adam and the patriarchs employed before the Deluge to prolong the term of human existence to eight or even nine centuries. Paracelsus professed the grossest pantheism. He admitted the existence of pure spirits without souls. According to him, all beings, even the minerals and fluids, take aliments and drink, and expel fæces. His physiological theory, a confused mass of the most incoherent ideas, is founded on the application of the law of the cabbala to the demonstration of the functions of the human body. The Sun has an influence on the heart, the Moon on the brain, Jupiter on the liver, Saturn on the spleen, Mercury on the lungs, Mars on the bile, and Venus on the kidneys and the organs of generation. Before attempting to explain the functions, or to cure diseases, the physician should know the planets of the microcosm, their meridian, their zodiac, their rising and setting; and it is by means of this knowledge that he attains to the discovery of the most hidden secrets of nature. The body is formed by the concourse of sidereal, that is, immaterial salt, sulphur, and mercury. Each of the elements may admit of all qualities, so that there may be dry water and cold fire. Another of his doctrines related to the *archeus*, a species of demon, which performed in the stomach the function of an alchemist, separating the poisonous matter contained in the aliments from that which serves the purpose of nutrition.

Nor was Paracelsus less absurd in his pathological theory. Returning always to magic, he assures us that it is the art of arts, and that from it all knowledge of medicine must be derived. He glories in passing for a magician, and even boasts that he had received from hell letters written by Galen, and had maintained, in the vestibule of that dreary region, keen disputes with Avicenna on portable gold, the elixir of the philosophers, the quintessence, the mithridate, and the philosopher's stone. He attributes diseases to five general causes, which he names *entities*, and which have relation to the astrological system; so that, instead of observing symptoms, a physician should consult the planets, in order to distinguish if the entity be divine, or astral, or natural, or spiritual, or poisonous. He declares that there is an essential difference between the diseases of men and those of women, because the *uterus*, as a microcosm within a microcosm, performs an important part in all the affections of women. To the menstrual blood he attributes the most extraordinary properties, particularly a poisonous quality. He explains each malady in particular by the help of his three principles of chemical entities, which he substitutes instead of the four elements of the ancients. In therapeutics and in materia medica his theory is altogether cabbalistical. He regards gold as a specific in all cases where the heart is the primary seat of the malady; recommends the study of anatomy and chiromancy in order to discover the virtues of vegetables; and states that, before employing any medicament, it is indispensable to observe the state of the constellations. In surgery he altogether rejected the use of cutting instruments, caustics, and even sutures, and pretended to cure fractures without bandages, by means only of comfrey. He employed the magnet in cases of hæmorrhage, hysteria, epilepsy, and the greater part of the spasmodic affections; and extended more than ever the abuse of talismans. But amidst all this absurdity and extravagance, Paracelsus had the undoubted merit of attempting to introduce into medicine the use of antimonial, mercurial, and ferruginous preparations, which have so efficacious an action upon our organs; and it is equally certain that alchemy, which ruined so many adepts, proved advantageous to the medical sciences, by reason of the important discoveries which incidentally resulted from the numberless experiments made by its professors.

Paracelsus published very few works in his lifetime, and those which are attributed to him exhibit so many contradictions that several of them have been ascribed to his disciples. It would be a useless waste of space to enumerate the titles of all his works; we shall therefore content ourselves with indicating the different complete collections. 1. The German editions, Basil, 1575, in 8vo, ibid. 1589–1590, in ten vols. 4to, and Strasburg, 1603–1618, in four vols. folio; 2. The Latin editions, *Opera Omnia Medico-Chymico-Chirurgica*, Francfort, 1603, in ten vols. 4to, and Geneva, 1658, in three vols. folio; 3. The French editions, *La Grand Chirurgerie de Paracelse*, Lyons, 1593 and 1603, in 4to, and Montbéliard, 1608, in 8vo. (See Adelung, *Histoire de la Folie Humaine*, tom. vii.; the *Biographie Universelle*, article Paracelse; and Sprengel, *Histoire Pragmatique de la Médécine*, tom. iii.) (A.)

PARACLETE, the COMFORTER, a name given to the Holy Spirit.

PARADANGA, a town of Bengal, in the district of Cooch Behar, and pleasantly situated on a small river, thirty-three miles north-east of Rungpore.

PARADISE, a term principally employed to signify the garden of Eden, where Adam and Eve were placed immediately upon their creation.

There have been many speculations as to the situation of the terrestrial paradise. It has been placed in the third heaven, in the orb of the moon, in the moon itself, in the middle region of the air, above the earth, under the earth, in the site occupied by the Caspian Sea, and under the arctic pole. The learned Huet places it upon the river formed by the junction of the Tigris and Euphrates, now called the *River of the Arabs*, between this junction and the division made by the same river before it falls into the Persian Gulf. Other geographers have placed it in Armenia, between the sources of the Tigris, the Euphrates, the Araxes, and the Phasis, which they suppose to be the four rivers described by Moses. But concerning the exact place we must necessarily be very uncertain, if indeed it can be thought at all to exist at present, considering the many changes which have taken place on the surface of the earth since the creation.

"Learned men," says Mr Miln, in his *Physico-Theological Lectures*, "have laboured to find out the situation of Paradise, which seems to be but a vague and uncertain inquiry; for the Mosaic description of it will not suit any place on the present globe. He mentions two rivers in its vicinity, viz. Pison and Gihon, of which no vestiges can now be found. The other two still remain, viz. the Hiddekel, supposed to be the Tigris, and the Euphrates, whose streams unite together at a considerable distance above the Persian Gulf. This gulf is eastward both of the land of Midian and the wilderness of Sinai, in one of which places Moses wrote his history. But since the formation of this earth, it has undergone great changes from earthquakes, inundations, and many other causes. The garden, however, seems to have been a peninsula, for the way or entrance into it is afterwards mentioned. We are told that a 'river went out of it;' which, according to some, should be rendered 'run on the outside of it,' and thus gave it the form of a horse-shoe; for had the Euphrates run through the middle of the garden, one half of it would have been useless to Adam, without a bridge or boat wherewith to have crossed it."

Christians, we presume, need not be told, that, however curious or amusing this inquiry may be, the determination of the point at issue is of no importance, since we are all well assured that the celestial paradise is that place of pure and refined delight in which the souls of the blessed enjoy everlasting happiness.

PARADOX, παράδοξον, in philosophy, is a proposition seemingly absurd, as being contrary to received opinions, but yet true in fact.

The vulgar and illiterate take almost every thing, even the most important, upon the authority of others, without ever examining it themselves. But although this implicit confidence is seldom attended with any bad consequences in the common affairs of life, it has nevertheless, in other things, been much abused; and in political and religious matters it has produced fatal effects. On the other hand, knowing that learned men, in order to avoid this weakness, have fallen into the contrary extreme, some of them believe every thing to be unreasonable or impossible that appears so to their first apprehension; not adverting to the narrow limits of the human understanding, and the infinite variety of objects, with their mutual operations, combinations, and affections, which may be presented to it.

It must be owned that credulity has produced more mischief in the world than incredulity ever has done, or ever will do; because the influences of the latter extend only to such as have some share of literature, or affect the reputation of knowledge. And since the human mind is not necessarily impelled, without evidence, either to belief or unbelief, but may suspend its assent to or dissent from any proposition, till after a thorough examination, it is to be wished that men of learning, especially philosophers, would not hastily, and from the first appearances, determine themselves with respect to the truth or falsehood, possibility or impossibility, of things.

A person who has made but little progress in the mathematics, though in other respects learned and judicious, would be apt to pronounce it impossible that two lines, which were nowhere two inches asunder, may continually approach towards each other, and yet never meet, though continued to infinity; and yet the truth of this proposition may be easily demonstrated. In fact, no science abounds more with paradoxes than geometry.

PARADOXI, a sort of mimes or buffoons amongst the ancients, who entertained the people with extempore effusions of drollery.

PARAGAUDÆ, amongst the Romans, were wreaths of gold, or of silk and gold, interwoven in, not sewed to, their garments.

PARAGOGUE, in *Grammar*, a figure by which a letter or syllable is added to the end of a word.

PARAGONG, a town of Northern Hindustan, in the province of Bootan. It is the capital of a district of the same name, and carries on an extensive manufacture in swords, daggers, arrows, and molten images of Buddha. The governor of the district has his residence here, dwelling in a well fortified palace, which is also a handsome building. Long. 89. 21. E. Lat. 27. 43. N.

PARAGUAY, formerly a province of the viceroyalty of Buenos Ayres, in South America, but declared an independent republic first in 1816, and again in 1826. It is bounded on the north by the province of Matto Grosso, in Brazil, from which it is separated partly by a river, and partly by a mountain ridge, its most northerly point being between the twentieth and twenty-first degrees of south latitude. The river Parana constitutes its boundary on the east, south-east, and south, with the exception of a comparatively small tract of country, called the Missions, which lies to the eastward, on the right bank of the Parana; and along the whole of the western side of the country flows the Paraguay, the confluence of which with the Parana, in latitude 27. 27. south, marks the limits of the country in this direction. In longitude it extends from 54. 40. to 58. 30. west from Greenwich, and comprehends an area of above 25,000 square miles, which is about half the superficies of England, exclusive of Wales.[1]

The history of Paraguay, from the time of its discovery until it unfurled the standard of independence, along with the other provinces, and shook itself free from European domination, presents but little except the usual story of the oppression and aggrandisement of the whites, with the fierce struggles and the ultimate submission of the Indians. But its annals since the revolution, when its destinies were intrusted to Dr Francia, one of the most remarkable men of his time, are replete with events equally interesting and instructive. According to Techo, the word Paraguay signifies the Crowned River; a name which it obtained from the Indians who inhabited the shores of the river wearing coronets made of feathers. Dr Southey, however, is of opinion that it is the same word as Paraguazu, or Great River; and this is supported by the fact, that the same word for a river is observed in the Para and the Parana. On the other hand, Azara informs us that the river and country of Paraguay derive their name from the Payaguas, who formerly inhabited that part of Brazil through which the river flows in the early part of its course, and are now the most domesticated and useful of all the Indian tribes, with the exception of the Guaranis. This name was altered a little by the Spaniards, who, substituting one letter for another, made it Paraguay instead of Payaguay. The country was discovered in 1526, by Sebastian Cabot, who was then in the service of Spain. This intrepid navigator ascended the Paraguay thirty-four leagues above its junction with the Parana, and there met an agricultural people, inhabiting the banks, but found them too fierce, warlike, and sagacious to be ensnared by promises, or induced to come to terms. After five years of fruitless attempts at negotiation, he was compelled to abandon the enterprise; and for some time the country remained almost unnoticed. In the year 1536, however, the Spaniards, after a sanguinary struggle with the natives, succeeded in forming a settlement; and in memory of the event, as well as in honour of the Virgin Mary, they called their fortified port Assumption. This was the origin of the capital city of that name, which increased so rapidly, that in eleven years afterwards it was considered as of sufficient importance to be constituted the seat or see of a bishop. The history of the country for fifty years after the first settlement presents merely a series of acts of hypocrisy and violence. The Guarani tribes, who inhabited Paraguay, and some other parts, were a brave but docile people; and though many lives were lost before the superiority of the Spanish power was acknowledged, yet, of all the tribes, the Guaranis, who were the most numerous, proved in the end the most easily and effectually reduced to obedience. But, satisfied with their subjugation, the Spaniards did little or nothing for their improvement; and it was not until towards the end of the sixteenth century that the Jesuits brought all the zeal and influence of their order to the task of civilizing the Guaranis, or, in other words, reducing them from a state of savage independence to one of civilized but complete subjugation. In the year 1586, the first settlement or mission of the Society of Jesus was formed in Guayra; and so rapidly did these settlements increase, that, in the year 1629, they amounted to twenty-one in number. These communities were of a threefold character, namely, religious, military, and manufacturing; for, whilst the Jesuits instructed the Indians in the elements of education and the truths of religion, they likewise trained them to habits of industry, and even taught them the art of self-defence. Each of the settlements was a considerable town laid out with straight streets. The houses, generally consisting of earth, where whitened, covered with tiles, and provided with verandas on either side, to preserve them from the sun and the rain. Each mission had a mother church, which was generally built of stone, and magnificently ornamented. Two curates, both Jesuits, were the only ecclesiastics who exercised parochial functions, and at the same time acted as inspectors of all civil economy.

In attempting to extend their spiritual conquest still further, the Jesuits were compelled by the Paulistas to fall back to the south of the Serra Maracaju, and concentrate their establishments between the Parana and Uruguay, in that part where these rivers approximate most closely. But at a subsequent period the Jesuits acquired an ascendency in Paraguay, as far as ecclesiastical authority was concerned; and for more than a century their influence remained unshaken. In the year 1752, when seven of the Jesuit missions were detached from Spain and annexed to Portugal, so averse were the Indians to this separation, that they had recourse to arms, and a war ensued, which is known by the name of the War of the Seven Settlements. But, after five years of hostility and bloodshed, they were entirely subdued, and their spiritual teachers, who had at first vainly urged them to submission, resumed their beneficent sway. The Jesuits, it is well known, were finally expelled from Brazil in 1760, under circumstances of unexampled cruelty; and in 1768, this was followed by their complete expulsion from Paraguay, as we learn from Cazal and the despatches of Bucarelli. During more than thirty years after this event the affairs of the country continued in a state of frightful disorder; cruelty, plunder, and misery in various forms prevailed; and the population of the Reductions, from having been upwards of 100,000, sunk to less than half that number.

With the change of masters which followed this event, the spell that bound the Indians was broken; and by the new plan of government there was established in the Guarani towns a system which in a few years led to the total ruin of the Jesuits' establishments. The successors of these missionaries appear to have been thoroughly embued with the worst spirit of religious bigotry, and to have possessed none of their redeeming qualities. Doblas, one of the administrators of the new system, and by far the most enlightened and efficient of their number, as well as the able historian of the Missions of Paraguay, strenuously urged the Spanish government to sanction such a change of management as would insure their preservation; and ultimately the king of Spain showed a disposition to adopt his suggestion. But it was then too late. The depopulation of the Missions was complete; and, in many places, the ruins of their churches and buildings are all that now remain to attest their having ever existed. The Jesuits have often been attacked and unsparingly calumniated by those who were interested in destroying the reputation of that celebrated order; but some authentic documents recently published will probably go far to correct many of the erroneous impressions which have thus been produced in disfavour of that body. It must always be kept in view, however, that, excepting the truly impartial testimony of Doblas, the records alluded to are the productions of decided partisans of the company of Jesus.[1]

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[1] In drawing up this article we have been indebted for much valuable information to Mr W. P. Robertson, author of Letters on Paraguay, who was detained a considerable time in the country by Francia, and experienced in his own case the rigour of that suspicious despotism under which it now groans.

From the commencement of the present century until the year 1810, the country continued tranquil; but when the tocsin of revolt was sounded throughout South America and Mexico, an attempt upon the part of Buenos Ayres to supplant the governor of Paraguay led ultimately to the establishment of an independent government in that country. In the month of October 1810 the junta of Buenos Ayres despatched a thousand men under the command of Manuel Belgrano, for the purpose of vindicating their authority in Paraguay, and attaching it to the republic of the United Provinces. This army penetrated without interruption into the heart of the country, and halted within about two days' march of Assumption, the capital. In the mean while the Paraguayans collected together a force of from five to six thousand armed men, and the hostile forces came in sight of each other at the village of Paraguany. A battle ensued, in which Belgrano was defeated, and obliged to enter into a capitulation, in virtue of which he ultimately withdrew from the province. But during the conferences which took place, both before and after the capitulation, Belgrano so infected the Paraguayan officers with notions of independence, that at length these took full effect on their minds. This short but triumphant appeal to arms had given them a consciousness of the possession of strength, of which they were not previously aware; and seeing that the number of Spaniards in Paraguay was small, and being also stimulated by the example of neighbouring states, by the recollection of former wrongs, by the instinct of independence, and by the hope of gain, the principal Creoles began more and more to detach themselves from the government of Old Spain, until at last, in the course of the year 1811, they resolved to make common cause against it.

A plan for achieving independence was consequently organized, but so badly concerted, that the secret began to transpire, when some of the officers, more courageous than the rest, resolved on taking a decisive step, before detection had destroyed all their hopes. They proceeded to the residence of the governor, Señor Velasco, and having entered it, pistols in hand, arrested that functionary. So rapidly were matters arranged, that the same morning two of the chiefs of the revolution, Don Fulgencio Yegros and Don Pedro Cavallero, were united with him in the government, and a congress was called. After this body had met, the members proceeded in a regular manner to depose the governor, and supply his place by a junta, which, in imitation of that established at Buenos Ayres, professed to act in the name of Ferdinand VII. But it proceeded with much more alacrity than any similar body in the other dependencies of Spain, and did not hesitate at once to proclaim the disjunction of Paraguay from the mother country. The junta consisted of a president, two assessors, and a secretary. The person appointed to the latter office was the celebrated Don Joseph Gaspar Rodriguez de Francia, since well known by the name of the Dictator of Paraguay.

Francia, although merely secretary of the government, not only controlled and ruled it with nearly absolute sway, but with a petulance inherent in his temper, and inseparable from his impatience of contradiction or restraint. The excesses which soon followed the revolution, and which, after being long fostered in the bosom of Francia, were brought to light, year after year, as his power ripened and his jealousy matured, are too well attested by numerous and impartial witnesses to admit of dispute. He entered into office a stern and unrelenting tyrant. His fixed and unalterable resolution was to obtain power, absolute and uncontrolled; and, like other despots, he disregarded not the commission of crime in any shape, if calculated to insure his object. It was only to make his ultimate success more certain that he opened up his schemes gradually, and increased his cruelties by successive steps; and he was really the more formidable to his victims, that his sphere of action was so limited, as to bring within the ken of his quick and jealous eye every individual of the petty population of his groaning country. His colleagues in office, Yegros and Cavallero, were men of mean capacity; and whilst they were exhausting in parade the pleasure of newly-attained power, the man destined to become dictator of Paraguay was planning, in secret, those designs which not only overthrew all competitors for office, and deposed his partners in the government, but left him the sole possessor of that iron sceptre with which he has ruled his people, and overthrown every presumptuous aspirant after liberty. From the moment of his attaining the rank of consul, he paid the closest attention to business. His first care was to organize a body of men called *Quarteleros*, from being shut up within the only barrack, or *quartel*, in the town. He also organized a body of militia for the defence of the country against external invasion. He pulled down the monastic institutions, because he knew well the influence of the priests over his bigoted countrymen; and influence, in his estimate of it, was crime. Every man of education was turned out of the civil department, and replaced by low-born and uneducated tools of the dictator. The Inquisition was abolished, because it carried the semblance of an *imperium in imperio*. No holy processions, no night services in the churches, were permitted, because Francia deemed none so likely to foster treason, or to arm the hand of the assassin against the enemy of the church. At length he entirely threw aside the mask which had hitherto imperfectly concealed the real ferocity of his disposition. Whilst he was yet consul, and only dictator *pro tempore*, he had contented himself with immuring his victims in prisons, from which he in no instance released them; but now not only were the jails insufficient to contain the unhappy objects of his suspicion, but the scaffold began to stream with blood, and to afford him an easier and quicker mode of ridding himself of every one whom he chose to consider as a political culprit. Vague and remote conjecture, the villanous tales of informers, nay, even an inauspiciously-interpreted look or action, entailed banishment or death upon the suspected or denounced individual. He founded a settlement, to which he gave the name of Tevego; and thither he banished, upon the most trivial pretext, or slightest suspicion, all his least formidable enemies. This place, which forms the Botany Bay of Paraguay, is 120 leagues above Assumption; except Bourbon, it is the most northerly point of that country; and being situated on a marsh, it is not only a hot-bed of malaria and mosquitos, but destitute of every thing capable of rendering existence tolerable. The original object of selecting such a spot for banishment was that of gratifying absolute cruelty of disposition; the collateral one, that of establishing a colony of outcasts sufficient to resist the incursions of the indomitable and ferocious tribe of the Mbayà Indians. The unsettled state of the neighbouring provinces caused many of their inhabitants to seek refuge in Paraguay; but the dictator, ever jealous of new-comers, sent most of them to languish as exiles in Villa Real and Tevego.

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[1] These religionists, who acted as missionaries in Paraguay, were certainly not so bad as their enemies represented them, and yet by no means so philanthropic and disinterested as their friends have described them. Aggrandisement for themselves, and complete dependence upon the part of the Indians, were the undeviating principles of their government. Uniform and constant labour was exacted from their subjects on the one hand; and a humane, mild, paternal, and wise rule was exercised in return; in fact, the chains of the Indians sat so lightly upon them as to be wholly imperceptible to their simple and guileless minds.

The dictator, proceeding on his worse than Chinese principles of excluding intercourse with all foreign states, laid prostrate the commerce of the country; and having thus crushed the energies, and cut off the resources, of thousands of his countrymen, he found it necessary to turn their attention to agriculture, and the manufacture of cloth from the native cotton of the country. This was pretty much as if the Tartar sovereign of China should prohibit the manufacture and exportation of *tea*, and set his subjects on the exclusive cultivation of rice and cotton for their own consumption. Less scrupulous than the head of the Celestial Empire, Francia did what the other has never attempted. He said, You shall have no intercourse with foreign countries; let the growth of the Paraguay tea, the cultivation of the Paraguay tobacco, the interminable forests which furnish timber, and the sugar-cane plantations which enrich your estates, be disregarded; and every man of you turn his attention towards deriving his means of subsistence from his own lands, and his means of clothing from his own looms. The merchant who had before made L.500 a year by the exportation of his commodities, was now ground down to L.50 at most, derivable from the cultivation of his estate. Ships rotted upon the beach; produce mouldered to decay in the warehouses; the inhabitant of a spacious house was reduced to a mud cottage; and this system Francia called an encouragement of agriculture. Having destroyed the spirit of the country, Francia now succeeded in laying prostrate its natural resources. Attempts were from time to time made to bring down the haughty authority of this despotic chief; but they were all in vain. Every conspiracy was detected, and every such detection conducted more numerous victims to the gallows, chains, dungeons, imprisonment, or banishment to Tevego. The towns of the whole country were placed under the most rigid discipline; every inhabitant of every house felt as if his father, brother, or wife, might be a spy; the whole land groaned and lay in abasement, under a trembling awe of its relentless governor. Bonpland, the enterprising companion of Humboldt, was detained nine years a prisoner, because he had dared to form an establishment for the manufacture and exportation of tea; and he was released at the end of that term, not from any latent spark of humanity on the part of the dictator, but because he had acquired not only great popularity in that part of the country where he was fixed, but a considerable property, of the whole of which he was stripped, when thrust forth at a moment's notice from his home. He was allowed to take with him barely as much as sufficed to carry him to Buenos Ayres. He only left Paraguay in the year 1831. The British subjects who had been detained by the arbitrary will of the dictator were released some years previously, by a happy interference on the part of Sir Woodbine Parish, then (1826) consul-general of Buenos Ayres. Francia's great desire was to establish a direct diplomatic intercourse with England, and he fancied that by releasing his *detenus* he would accomplish his purpose. In this he was mistaken; and upon finding himself afterwards disappointed, he gave vent to an ungovernable fit of rage.

Paraguay, with the exception of the part which faces the north, appears to be wholly enclosed by the rivers Parana and Paraguay; and these noble streams constitute the most remarkable physical features of the country. There are, besides, a great number of smaller currents of water, affluents of the large rivers, which traverse the country from east to west and from west to east, falling respectively into the Paraguay and the Parana. The country is thus abundantly supplied with water for the purposes of agriculture; and, with regard to navigation and commerce, the breadth and depth of the two great rivers by which it is nearly surrounded place it almost on an equality with an island of the ocean. Generally speaking, the face of the country is level; and, though sometimes undulating, and here and there studded with hills, it is destitute of any mountain ranges, notwithstanding that, upon most maps, a cordillera, apparently of great extent, is made to traverse the country, having a general bearing from north to south. These elevations, which are situated considerably nearer the Parana than the Paraguay, are not deserving of the name of mountains. The rocks chiefly found in the country are arenaceous, not calcareous, and they vary in hardness and in grain. There are here no mines of the precious metals, and the minerals which belong to it do not so materially differ from those found in many parts of the United Provinces of the Rio de la Plata as to require specific mention. There are no salt marshes or brooks of any size, such as are common in this region of America; but a substitute for them is found in the earth called barrero, which consists of a mixture of clay and salt. This is devoured with such avidity by all animals, that they cannot be driven from it by blows, and have been known to die in consequence of swallowing too much of it. Salt is obtained in Paraguay by collecting the white efflorescence which is found in some valleys during the dry season. This is dissolved, filtered, and subjected to evaporation, when the crystals of salt are formed; but the quantity produced is so small that Paraguay is dependent on Buenos Ayres for supplies of this necessary article. The soil of Paraguay is invariably fertile, and of the same quality throughout.

The climate, although hot compared with that of Great Britain, is highly salubrious. Azara, whose account of the country, although half a century old, is still the best which we have, found the heat throughout the summer to average 85° of Fahrenheit at Assumption, the capital. This was in his chamber; but on very warm days the thermometer stood at 100°. In winter it descended to 45°, which may be taken as the medium temperature of this season; but Azara says, that, in extraordinary seasons, he found water congealed in the court of the house which he occupied, although this statement has been questioned. It is generally observed in the country, that it is always cold when the wind blows from the south or from the south-east, and warm when it blows from the north. In fact, the heat and the cold seem to depend much more on the winds than on the situation or the declination of the sun. The most common winds, and these invariably hot ones, blow from the east and the north. Those from the south and south-west are much less frequent, though invariably cool and refreshing. A west wind is scarcely known. The climate is moist; and a considerable quantity of rain falls during the summer months (which in this quarter of the globe correspond to those of our winter), accompanied by terrible storms of thunder and lightning.

In the abundance and variety of its vegetable productions, Paraguay equals the most prolific portions of South America; and in one tree, that which supplies the celebrated *maté*, it stands unrivalled. Not that it is solely confined to this country, for it is found more or less over the whole table-land; but it is produced there in the highest perfection, and in the greatest quantities. The *yerbamaté* grows to a goodly size, and is cut to supply the market in every state, from that of a shrub to that of a full-grown tree. It resembles the tea-plant of China, and being in fact a species of wild tea, it is commonly known in commerce by the name of "Paraguay tea." The leaves and thin stalks are cut off every two or three years, that period being necessary for its reproduction. The small branches, when gathered, are dried by means of fire; the leaves are then roasted and partially bruised, after which they are packed up in hides, and sent to the different markets of South America. This leaf constitutes the principal article of export from Paraguay. The beverage which is produced from it by infusion has a bitter flavour, not unlike Bohea; and in some parts of the continent the use of it is said to have prevailed amongst the Indians from time immemorial.

Every variety of wood is extremely abundant in Paraguay; the territory of this republic being in fact as remarkable for the extent and excellence of its forests, as that of Buenos Ayres is for the total want of them. The vessels which are built here are extremely durable. Some species of the wood of Paraguay are so hard as to resist the best tempered axe. The hapacho, especially, is a wood of the hardest and most durable kind, equal, if not superior, to the best of our oak. Of the hapacho, vessels are built which live on the waters for fifty years, and rafters are made which support the roofs of houses for double that time. So hard and close is the grain of this wood, that no worm can penetrate it, and no rot can ever assail it. The carts of Buenos Ayres are made of this or similar woods; the algarrobo, the urundey-pita, and the urundey-iray, being amongst the strongest. The last, being very handsome, is likewise used for furniture; and when polished, it is equal in beauty to rosewood, but of a lighter colour. The other trees the timber of which is in general use are, timbo, and the tatayiba or wild mulberry; lance-wood, and the orange tree, of which gun-stocks and parts of carriages are made; carandey, a large palm-tree, yielding a very hard wood; the tatare, strong, and much used in the construction of vessels and machinery, as is also the yberaro; with the cedar and others. There is a tree found here which grows in a very singular manner, the trunk being composed of several stems closely twined round one another, thus forming to appearance one solid mass. The bark of the cebil and curupahi, found in Paraguay and Corrientes, is used for tanning. There are also several trees and plants which the natives make use of for dyeing their linen. A large tree called palo santo, or holy wood, produces an odoriferous gum, which is extracted by boiling pieces of the wood, and is used as a perfume. The incense tree, so called from the gum which it produces, is used in the churches as incense. The mangaysy produces gum elastic, of which a very durable sort of match is made. There are many other trees in the country which yield different kinds of gum, and some are reputed to possess great medicinal powers. With these a Jesuit made numerous experiments upon the Indians, during a residence of forty years amongst them; and having himself lived to the age of a hundred and twelve years, his medical aphorisms were held in high veneration. Rhubarb jalap is amongst the numerous medicinal plants which grow in Paraguay. The cordage used in the vessels is mostly made from the fibres of plants which are found in the country. Tobacco, coffee, sugar, and cotton, are all cultivated here; and maize grows to great perfection, being much used as an article of diet. Rice, indigo, cotton, and the vine, which thrives but indifferently, are also cultivated to a great extent. A root called aipim or pompin is sometimes made use of as a substitute for bread. Honey and wax, vegetables, and tropical fruits of various kinds, are abundant. Indeed Paraguay has always been held in the highest estimation for the abundance, variety, and value of its productions. The animal kingdom is as extensive and various as the vegetable. Most of the animals belonging to this part of South America are found in Paraguay; amongst which may be mentioned the cougars, jaguars, tapirs, and the water-wolf. The feathered tribes in particular have long been celebrated for their number and their beauty; including the ostrich, parrot, vulture, turkey, humming-bird, duck, and other game. Boas, rattle-snakes, lizards, and other animals, are plentiful; and ants, locusts, and other insects, are numerous and troublesome, sometimes very destructive. Immense herds of cattle roam in the vast plains of Paraguay, and their hides and tallow constitute considerable articles of export.

The inhabitants of this country are now almost wholly engaged in agricultural operations, a portion only giving such attention to manufactures as the wants of the whole demand. Before the non-intercourse system of Francia was introduced, the population of the country was chiefly employed on articles of export; the yerba-maté, tobacco, lumber of every kind, sugar, rum, tanned hides, &c. But when, under Francia's rule, these became useless as exports, his own policy, as well as the natural wants of the people, turned the industry of the labouring masses into new channels. The importation of cotton was superseded by the great additional growth of the native plant. Rice, maize, the yucca root, and various leguminous and succulent plants, shared an equal cultivation with the sugar-cane. The breeding of horses and of cattle was enjoined and encouraged; and Francia's whole power was employed to realize his boast, that he would make the people dependent on themselves, and not on foreigners.

Such have been a few of the results of the anti-social policy of Dr Francia. He has changed the richest and most commercial province in the old viceroyalty, Buenos Ayres excepted, into perhaps the poorest, notwithstanding the prodigal hand with which nature has scattered over the country her most luxuriant productions. He has arrested the progress of civilization, and forced the inhabitants of Paraguay to retrograde towards barbarism. He has demoralized an active, hospitable, open-hearted, and simple-minded people, and converted them into a ferocious soldiery or a mass of spies on the one hand, and a terror-striken, slavish multitude, on the other. And to these miserable results he has waded through the blood of innumerable victims, who have either perished on the scaffold, or sunk to the grave in the noisome dungeon and the pestilential swamp, where a slower but not less certain death awaited them.

Before the reign of Francia commenced, the trade of Paraguay with her neighbouring provinces, and particularly with Buenos Ayres, was very considerable. About eighty square-rigged vessels were constantly employed in the trade, besides a great number of river craft, under the names of garandumbas, piraguas, balsas, and chalanas. The exports consisted of about 40,000 bales, containing 8,000,000 lbs. of yerba-maté, 7000 to 8000 petacones of tobacco, containing 1,000,000 lbs.; and these two articles produced about one million two hundred thousand dollars annually; whilst lumber, rum, sugar, tanned hides, and a variety of minor articles, produced about half a million more.

Before Francia assumed the reins of government, the Paraguayans never thought of extending their care to the cultivation of any other article than the tobacco-leaf, the sugar-cane, cotton, and the yucca-root. Maté, which grows without any aid from art, in the vast forests of the north and east, engaged almost all hands. Melons, oranges, Indian corn, and other fruits, together with rice, maize, and the two sorts of yucca-root, were now cultivated upon a more extended scale, and with much greater diligence; and vegetables, which were hitherto unknown in Paraguay, now cover the plains. During 1819, that destructive insect the locust, which visits Paraguay every five or six years in such multitudes as even to obscure the sun, spread devastation over a circumference of more than eighty leagues of country. A scarcity seemed inevitable, for the preceding harvest had been unusually bad; but, to prevent this calamity, the dictator ordered the farmers to sow, a second time, a considerable portion of the land which had been laid waste. The experiment was completely successful, and the second harvest proved one of the most abundant that had ever been known. The proprietors had never before dreamed of reaping a double crop in one year. Artisans also sprung up under the auspices of the despot; and out of rude blacksmiths, shoemakers, and masons, he contrived, by an indefatigable, and in many cases personal superintendence, to create a double number of expert whitesmiths, saddlers, and architects. Of the amount of the trade of Paraguay no data from which to form an estimate have been obtained. The two great resources of the country are the forests of timber for building, and the herb of Paraguay; and these form the staple articles of export. But, besides, there are still sent out of the country tobacco, sugar, cotton, sweetmeats, tapioca, rum, wax, tallow, and hides. The imports are not numerous; for it has been the constant aim of the dictator to render his country, if possible, altogether independent of any other.

It must be very evident, from what has been said, that the whole power of government is centred in the dictator. There are, indeed, in imitation of the Spanish system, a minister of finance, a secretary of state assisted by an under secretary, and a remnant of the ancient cabildo, consisting of two alcaldes, stationed at Assumption; conciliators, and commissioners of police, together with a "faithful executioner," an inspector of markets, weights, measures, and some others; and, lastly, "an advocate of minors," whose duty it is to watch over the interests of minors and of slaves. But the highest of these officers is little better than a head clerk, who merely acts under the orders of the dictator. The republic is divided, as in former times, into twenty sections or *comandancias*, four of which have for their capitals respectively the towns of Neembucu or Villa del Pilar, Villa Rica, Yquamandiu or Villa de San Pedro, and Villa Real de la Concepcion; the only towns in the whole country, besides Assumption, which is distinguished by the name of *ciudad*, the Spanish for city, the others being called villas. But since the suppression of their cabildos, which were charged with the local administration of justice, these towns no longer enjoy any exclusive privileges. Each section is under the authority of a commandant, who executes the orders of the dictator, directs the operations of the police, decides on minor offences, and exercises the functions of conciliator. He has under his orders some inferior officers of police; and there is also in each section a receiver of taxes. The laws by which Paraguay ought to be governed are those made in the time of the Spaniards; but they have been so altered, first by the junta, and subsequently by the dictator, that the will of the latter may be said to be the law of the country. Justice is administered in civil cases by the parties appearing before the commandant or one of the alcaldes, according as the place of trial is in the capital or in the country, and by their pleading their cause in person. This appears to be a court of conciliation similar to that which is established in Norway. If the attempt at adjustment prove unsuccessful, the cause goes in the first instance before one of the alcaldes, who pronounces a judgment, from which the parties have the right of appeal to the dictator. In criminal cases he is generally the judge himself; and he always proceeds in a summary manner. With regard to punishments we can only speak generally. They are severe, death being the award of crimes which in Great Britain would only be visited by a few weeks' confinement; and execution is made to follow the sentence as quickly and surely as the thunder-peal follows the flash of lightning. There are two kinds of prisons, namely, the public prison and the state prison, and both are kept in a wretched condition. The prisoners are treated with the utmost severity, and attempts to escape from these horrid places of confinement are punished by death. The police is exercised in Paraguay by all those in office, from the dictator down to the lowest functionaries, called zeladores. All the officers of government, including a train of spies, and also the regular troops and the militia, constitute one great body of police, which exercises a surveillance much stricter than that of France under Fouché. Passports are not only necessary to a person who wishes to quit the country, but also before he can travel twenty leagues from his residence. The whole population is thus kept in a sort of captivity. The post-office is also strictly looked after; and indeed the system of police is a source not only of great annoyance, but often of great loss, to the inhabitants. There is kept up a regular army of about 3000 men; and the body of militia, which is entirely under the orders of the dictator, is 10,000 strong. Every native of Paraguay must enter the service as a private soldier, and learn the military exercises; and with regard to the militia, the name of every free man in the republic who has arrived at the age of seventeen, and is capable of bearing arms, is inserted in the rolls. There is, besides, a troop of artillery, and a small naval force.

The revenues of the state arise from tithes, a tax upon shops and storehouses in the capital, an import and export duty, the sale-duty, stamps, postage of letters, fines, confiscations, "droits d'aubaine," and the produce of the national domains. The tithes are the most productive source of the public revenue; they are levied upon all species of agricultural produce, upon flocks and herds, and even upon poultry. The import and export duties can be received only at the custom-house at Assumption, and both are very heavy. The duty upon all sorts of goods brought into the country is nineteen per cent. *ad valorem;* but the duty is calculated on the retail price, and there is an additional impost of four per cent. as sale-duty, so that the import-duty cannot be less than thirty per cent. The sale-duty is levied upon every thing that changes owners, except agricultural produce, and even for this there is a charge made at Assumption. On articles exported the duty levied is nine per cent. *ad valorem.* The other branches of the revenue, such as the stamp-duty and the tax upon letters, yield annually a considerable sum. The national domains of Paraguay extend over almost the half of its territory, consisting of pasturage-lands and forests, the Jesuit Missions, the possessions of other religious corporations, and a great number of country houses and farming establishments confiscated by the dictator. The revenue must therefore be very considerable; but of its actual amount no one except the dictator has any idea.

When Dr Francia assumed the reins of government, he placed himself at the head of the church as well as of the state. The bishop, who opposed the revolution, was superseded by his vicar-general, Pay Montiel, a creature of the dictator's. Religious corporations were suppressed, and the clergy were secularized, chiefly by reason of the dictator's inextinguishable hatred of all institutions which bore any semblance of independence. In short, from the contempt in which he held the monks, he did every thing in his power to throw ridicule upon the monastic order. In Paraguay, as well as in the rest of South America, the education of youth was formerly intrusted exclusively to the monks, who established schools in the convents. Subsequently elementary schools, taught by lay masters, were established in all the districts, and a college of theology was founded at Assumption. The latter was suppressed by the dictator in 1822; but he allowed the elementary schools to remain, without, however, taking any steps to improve them. But as no obstacles were thrown in the way of establishing private seminaries, several of these have been opened in the capital, and education is rather on the advance. With regard to literature, in the ordinary acceptation of that term, it may be said to be wholly unknown in Paraguay. In 1827 there was not a printing-press in the country; but since then, this instrument of civilization in a free country, and of oppression in an enslaved one, has been established, and of course exclusively used by the dictator.

The population of Paraguay has been variously estimated, by those who have visited the country, at from 300,000 to 500,000 souls; but the Weimar Almanac for 1835, without giving any authority, states the number as high as 600,000. The great mass of the inhabitants are Creoles; the Indians composing about one tenth, and the mixed race and the black about two tenths, of the whole population. The natives of Paraguay are gifted with considerable natural talents, and are of a mild, hospitable, and generous disposition, but careless, unsteady, and as easily swayed to evil as prompted to good. In regard to morals, their minds may be said to hang in even balance between virtue and vice, and readily to take an inclination either way. Hence the remarkable influence which the Jesuits had over them; hence also the scenes of anarchy and bloodshed which followed their expulsion; and hence, lastly, the secret of Dr Francia's system of despotism. Although not possessed of the ardour of the inhabitants of the torrid zone, they support the greatest fatigue with courage and perseverance; but at other times they will remain whole months in a state of the most complete inaction. They are proud of their ancestors, as having been the founders of the first establishment formed in South America, and they have always been distinguished from the other Creoles by their national spirit. In Paraguay the conquerors have adopted the language of the conquered, and very many of the Creoles are perfectly ignorant of Spanish, particularly the female part of the rural population. In the mixed races of Indian and black, the child follows the condition of the mother, and is free or servile accordingly. Although the men of colour are in a great measure free, yet they have always been supposed to be unfit for office; and notwithstanding that, since the revolution, some of them have been admitted to places of trust, the ancient Spanish prejudice is not the less strong against them. The blacks are very few in number.

That part of Paraguay which is known under the name of the Missions is governed in a somewhat different manner from the rest of the country. It extends over a surface of 600 square leagues, on the right bank of the Parana, to the south-east of Assumption. The population consists of eight tribes of Indians, and some thousands of whites, who obtained land from the government, and established themselves there, after the expulsion of the Jesuits. The white population is governed by the commandants, as in the other parts of the country; but the Indians attached to the soil, and condemned to work on the state lands, have peculiar officers, who, under the name of administrators, manage these lands, besides exercising the functions of commandants. These two classes of functionaries are under a lieutenant of the government, who has the chief command of all the country of the Missions, but without any control over matters of finance. Several other villages inhabited by Indians in the interior of the country, and which formerly belonged to the Jesuits or other religious communities, have also managers set over them, and are subjected to the authority of the commandant in whose section they happen to be situated. The condition of the Guarani Indians, who are still in the Missions, is inferior to that of the slaves. In the time of the Jesuits, the Guaranis were tolerably well fed and partially clothed; and the fathers, by allowing them processions, dancing, and music, upon holidays, contrived to reconcile them to a state of dependence, and ameliorated their condition whilst they profited by their labour. But after the expulsion of the Jesuits, the managers who succeeded them were chiefly occupied in pillaging the settlements, overworking the Indians, and rendering their fate still more wretched by the utter destitution in which they were held. Since the year 1823, however, the power of the managers has been contracted by the dictator, and neither purchases nor sales have been allowed to be made without his permission. He also employed the Indians in the service of the government.

Assumption, the capital city of the republic of Paraguay, is built in the form of an amphitheatre, on a rising ground, on the left bank of the river Paraguay, in latitude 25. 17. 15. south, and longitude 58. 5. west from Greenwich. It has been so completely altered by the dictator, that little of the ancient city remains. But the idea of rebuilding it in a more regular manner occurred to him in the year 1820, upon the discovery of a conspiracy against his life. Its streets were crooked, irregular, and the greater number of them so narrow as to deserve only the name of lanes. The houses, consisting only of one floor, generally stood apart from each other, and being interspersed with trees, little gardens, brushwood, and patches of verdure, they presented the aspect of a village rather than that of a city. Numerous springs issued from the ground in every part of the town, and formed streams, or stagnated into pools; whilst the rain furrowed and cut up almost all the sloping streets. The dictator commenced his architectural reformations by tracing out, in the least populous parts of the city, longitudinal streets, from north-west to south-east, crossed by others at right angles, all of which were ordered to be made from thirty-five to forty feet in width. These new streets served him as a model for the others which were to be opened throughout the city. They were distant from each other one hundred paces; but whenever a public building interfered, the space was either diminished or augmented, in order to leave it standing. The proprietors of houses which interfered with the new line of street were ordered to demolish them; other buildings were pulled down by the mandate of the dictator, and their materials employed in levelling the ground. In short, he completely destroyed the old city; and as he had only to issue his commands to insure obedience, a new one soon rose in its stead. The owners of the dwellings which were thus demolished were not indemnified for their loss, and many rich proprietors were compelled to build mansions on sites pointed out to them. The dictator paid only the master workmen, whose plans were executed by some hundreds of prisoners. The various divisions of the country were obliged to supply all the materials gratuitously; and if the buildings carrying on were outside the capital, the owners of them were also bound to furnish a certain number of workmen. It was in this manner that the fortresses on the frontiers, and several barracks and other edifices at Neembucu, at Assumption, and at Villa Real, were constructed. New roads were also opened through the woods, and others which had been broken up by the rains were widened and repaired. Forty houses were built and let for the benefit of the state; and at every step in the progress of these operations the country people were called upon either for their personal services or for the use of their cattle. The result has been a perfectly renovated city, containing a number of spacious public buildings, large streets, and handsome private mansions. Assumption is the seat of government and the residence of the dictator; and here are all the different offices for the transaction of public business. The number of inhabitants may be estimated at 12,000.

Paraguay, a great river of South America, which forms the western boundary of the republic just described. Its head waters are formed by a great number of streams which rise in those mountainous ridges called Sierra del Pary, or Paraguay, a portion of the extensive Paricis, situated in the Brazilian province of Matto Grosso, in latitude 13. 30. south. A little below the last of a series of seven lakes, called the Sete Lagoas, which communicate with each other by narrow outlets, the Paraguay flows for a short distance through a swampy country in a northerly direction; it then winds round by the west, and takes a southerly course, which it maintains to its confluence with the river Parana, at the south-western extremity of Paraguay. The first large stream that joins it is the Xauru, which originates in the campos of the Serra Paricis, and after flowing a long way southward, bends to the east-south-east, and falls into the Paraguay in latitude 16. 25. Father Quiroga informs us, that, below the Xauru, the Paraguay separates into two considerable branches, the principal one running in a narrow but deep channel through the Xarayes, and the other branch flowing some leagues to the westward. The Xarayes is an immense lake formed by the abundant rains which fall during the months of November, December, January, and February. At this season the streams and rivers which feed the Paraguay become prodigiously swelled; and the latter river, unable to continue in its legitimate channel, inundates the country for many leagues on both sides. A great part of the beds of the St Lourenço, Tacoary, and Mondego, and other tributaries on the eastern side, as well as the small lakes on the western side, which appear to remain permanently, become portions of this periodical Caspian; and the elevated lands assume the appearance of islands, inhabited by an accumulation of birds and wild beasts. Whilst the floods continue, it is customary to navigate over the plains where the current is less rapid, traversing prodigious plantations of rice annually reproduced by nature without any human assistance, or sustaining any damage from the waters, because it grows as they increase, always presenting, besides the ear, a considerable portion of the stalk above the flood. As the quantity of rain which falls is much greater in some years than in others, the size of the Xarayes varies accordingly; and as its figure or contour depends on the nature of the country over which it spreads, it is also extremely irregular, and cannot be accurately described. Azara, who is always to be depended upon, thus speaks of this great lake. "It commences before the seventeenth degree of latitude, and it may have in this place twenty leagues of breadth to the east of the river Paraguay. It preserves nearly the same size until the twenty-second degree, that is to say, during more than one hundred leagues, without speaking of the Sugar Loaf, Pau-de-Azucar, and other little mountains which it surrounds with its waters. To the west of the same river the lake commences at 16. 30. and continues to 17. 30., immersing many leagues of the province of Chiquitos. From 17. 30. to 19. 30. its extent is inconsiderable; but afterwards, to the twenty-third degree, it continues to extend much in the Chaco, and still more in the country of the Chiquitos. We may, by approximation, estimate its length at one hundred and ten leagues, and its breadth at forty." During a great part of the year it remains perfectly dry, and covered with the corn-flag and other aquatic plants. There are several other lakes of the Paraguay, of much the same nature as the Xarayes, such as that of Aguaracaty, about the twenty-fifth degree of latitude; those which are found to the north and south of the lake Ypoa, situated under the twenty-sixth parallel; those of Neembucu, under the twenty-seventh; and a multitude of others, situated on the eastern margin of the Paraguay, and on all the streams which flow into it.

The affluents of this great river are very numerous. The Porrudas, or St Lourenço, joins it in latitude 17. 52., some writers say nearly a degree farther south; and the Tacoary, in latitude 19. 15., in front of a square mass of an elevated range, called Serra Albuquerque. Still further south are the mouths of the Mondego, thirty-five miles below which are two high mounts, fronting each other, upon the banks of the Paraguay. On the western mount is built Fort Coimbra. The Tepoti flows into the great river, in latitude 21. 45.; and this is nearly the limit between what is called the High and the Low Paraguay. The following is the order in which the rivers fall in, according to Father Quiroga, who navigated the Paraguay from the mouth of the Xauru to the confluence of the Parana. The embouchure of the Corrientes is in latitude 22. 2.; that of the Guarambari, in 23. 8.; that of the Ipaneguazu, in 23. 28.; that of the Ipanimini, in 24. 4.; that of the Xexui, in 24. 7.; that of the Quarepoti, in 24. 23.; that of the Ibobi, in 24. 29.; that of the Mboicaé, in 24. 56.; and that of the Salado, in 25. 1. A little below the city of Assumption, the Pilcomayo runs into the Paraguay by three mouths, after a very long course, its origin being amongst the mountain ridges where the city of Potosi is situated. The mouth of the Tebiquari is in 26. 35. The Bermijo, sometimes denominated the Rio Grande, joins in latitude 26. 54., eleven leagues of direct distance from the city of Corrientes, where the magnificent junction of the Parana and Paraguay takes place, in latitude 27. 27. and longitude 58. 22. west of Greenwich. The combined rivers bear the name of Parana till the confluence of the Uruguay, when all these appellations are sunk in that of the Rio de la Plata. The Spaniards, however, sometimes call the river by the latter name as far up as the junction of the Pilcomayo. Of these tributaries of the Paraguay, by far the largest and most important are the rivers Pilcomayo and the Bermijo. They offer great advantages to a commercial people; but, from the scanty population of the country through which the greater part of their course lies, these have not been turned to proper account. Both rise in Bolivia, the first, as has been mentioned, near the city of Potosi, and the second in the vicinity of Tarija. They descend at first with considerable velocity from the heights where they originate; but after they reach the level country, they flow in a tranquil and majestic current. According to the best information, they possess no inconvenience except their numerous windings, which arise from the want of fall in the ground of the Gran Chaco, through which they run, and which is the most level tract of country in all South America.

The Paraguay is navigable for vessels of a hundred to a hundred and thirty tons, provided they do not draw more than ten or at most eleven feet of water. One ship, indeed, of three hundred tons burthen, called the Primera, was built at Villa Real, and floated down the stream to the ocean. To obtain correct ideas of the breadth and depth of the Paraguay, Azara measured it at a time when it was lower than it had ever been known to fall in the memory of man. The breadth in several parts was found to be 1332 French feet; and from soundings made to ascertain its depth, and experiments to prove the velocity of its current, Azara calculated that it discharged, when at the very lowest, 98,303 cubic toises of water per hour. The mean quantity, he supposed, would be double this at least, if not more; so that, according to his estimate, the Paraguay discharges throughout the year, at the city of Assumption, nearly two hundred thousand cubic toises of water per hour. So little does the country slope in this part of the South American continent, that it has been calculated that the Paraguay in its course from north to south does not fall above one foot between the eighteenth and twenty-second degrees of latitude. At the capital the waters of the Paraguay are always clear; for the rains which fall either above or below that city are not sufficient to trouble so large a stream. The periodical increase of the river commences at Assumption in the end of February, and the augmentation continues with admirable equality till the end of June. It then begins to decrease in the same regular manner, and this continues during an equal space of time. This periodical increase is much greater in some years than in others; and at Assumption the waters sometimes rise five or six toises above their ordinary level, thus inundating a great part of the country; yet there is little variation at the commencement or at the end. This increase of the river, which, singularly enough, does not begin till the rains have ended, appears to be thus produced. All the rain which falls is first collected in the great natural reservoir Xarayes; and it is not until this is full to overflowing that it discharges itself into the river Paraguay. We find that the Parana, which has no basin of this description to collect the periodical rains, is at its greatest height in December, about a month after the rainy season has set in; so that by this singularly happy arrangement, the rivers Parana and Plata are kept during a great part of the year at a very considerable size. (R. R. R.)

PARAIBA, or Parahyba, a province of Brazil, in South America, bounded on the south by Pernambuco, on the north by Rio Grande da Norte, on the west by Sera, and on the east by the Atlantic Ocean. It comprehends about two thirds of the old captaincy of Itamarca, and has between eighteen and nineteen leagues of sea-coast, whilst towards the interior it extends westward about sixty leagues. It derives its name from the river Paraiba or Parahyba, which, originating in the Serra da Jabitica, in Cayriris Velhos, not far from the source of the Capibaribe, runs to the north-east, and discharges itself into the Atlantic by two mouths on either side of the island of St Beneto. Its principal tributary is the Paraibuna, which flows down from the back of the Serra da Montequeira, under the name of the Rio Preto, which is a mere translation of the Indian name for the river. It is about fifty yards in breadth at the junction, flowing with a rapid and turbid current, over a sandy channel eminently auriferous. Caldcleugh informs us that the current of the Paraiba is also very rapid, being about seven miles in the hour, and the water cool, being twelve degrees under the temperature of the air. "The road was excessively bad, being extremely narrow, with a gulley down the centre; and the soil being a red clay, was very insecure, from the humidity. From the summit the views on all sides were magnificent; but more particularly the one which extended along the valley of the Paraiba. Here and there the eye caught a glimpse of the river glistening amidst the deepest and most luxuriant vegetation." This description does not agree with the account sometimes given of Paraiba, that two thirds of the whole surface are incapable of any kind of culture. Mr Southey justly characterizes this statement as very erroneous; and recent travellers confirm the fact, that a great part of it possesses a prolific soil, and an agreeable although hot climate. The surface of the country, however, is very uneven, elevated ridges traversing it in various directions. Mr Koster travelled to Paraiba from Recife, by way of Goiana. The road between Goiana and Paraiba, a distance of thirteen leagues, presents nothing particularly interesting. The hills are steep, but not high; the principal objects are woods, plantations, and cottages. Returning by the sea-coast, he found a considerable portion of it uninhabited; but wherever the land was low, and the surf not violent, cottages were seen, and the banks of the rivers were partially settled. When the action of the tide ceases, the streams all become insignificant, and most of them quite dry. Nearly the whole of Brazil is celebrated for its vegetable productions, particularly timber; and Paraiba is not deficient in this respect. It is noted for the excellence of its Brazil wood, and its sugar, the culture of which, however, has much declined, on account of the droughts which are frequently experienced here; and cotton has taken its place, that plant being said to endure a want of water better than the cane. In the year 1820 a few Britons established themselves here, in connection with some merchants at Pernambuco, for the purpose of reviving and extending the trade. The exports of sugar at one time exceeded nine hundred chests annually, but in 1819 it had sunk to less than half that quantity; whilst in the same period the cultivation of cotton had increased in proportion as the cane had decreased.

Paraiba, the capital of the province, is situated on the south bank of the river Paraiba, about ten miles from the sea, the river being navigable for a considerable way above the town. The port is capacious and secure, and defended by two or three forts. Vessels of one hundred and fifty tons can pass the bar; sumacas can ascend to the capital, and canoes as far as the town of Pilar, which is situated about forty miles higher up. When this captaincy was taken possession of by the Dutch in 1634, it contained only seven hundred families and twenty engenhos. They changed the name of the capital to Ferdinand, in honour of the Prince of Orange; and gave a sugar loaf for its arms, in allusion to the great quantity of sugar obtained from the district, and in conformity to a plan then adopted for granting armorial bearings significant of the principal leading articles in the different captaincies under their dominion. The principal street is broad and well paved; the houses are mostly of one story, but some of the buildings are described as handsome. There are several large and respectable convents here, but of late years they have fallen into decay. Indeed the same thing may also be said of the city, for much of the commerce which it once enjoyed is now centred in Recife, a seaport in Pernambuco. The lower town, which consists of small houses, is situated, Mr Koster states, upon the borders of a spacious basin or lake, formed by the junction of three rivers, which discharge their waters into the sea by one considerable stream. These rivers are probably the Paraiba and its two confluents the Guarahu and the small river Unhaby. "The banks of the basin," he adds, "are covered with mangroves, as in all the salt-water rivers of this country; and they are so close and thick that there seems no outlet. I did not follow the river down to the sea, but I understand that there are in it some fine islands, with good land, quite uncultivated." One of these has since been cleared, and some salt-works erected upon it. Paraiba lies out of the road from the sertam to Recife; that is, out of the direct way from the towns upon the coast farther north; the inhabitants of the interior will therefore, in preference to Paraiba, make for Recife, as the more extensive market for their produce. Notwithstanding the richness and fertility of the lands of this province, a decided preference is given to plantations nearer to Recife, so that those of Paraiba are to be purchased at a much lower price. The population of this small city may amount to three thousand.

Besides the capital, this province contains seven towns in the eastern part, or that next the ocean, with a few arraials; and two in the western part. The names of those in the east are, Pilar, Alhandra, Villa Real, Villa do Con-de, Villa da Rainha, St Miguel, and Montemor; and those in the west are Pombal and Villa Nova da Souza. None of them are of any extent or material importance. Villa da Rainha, commonly called Campinha Grande, stands in an extensive plain, one hundred and twenty miles north-west from the capital, near a lake which supplies the inhabitants with water. In seasons of drought, which are by no means rare, the lake is dry, and the inhabitants are compelled to fetch their water a distance of six miles. The river Mamanguape, whose embouchure is ten miles north of Point Lucena, but dry in summer a few miles up from the sea, gives its name to a settlement near its banks, which is larger than most of the towns of the province. It is a thriving place, and forms a convenient stage between Rio Grande and Goiana. The population of Paraiba was estimated in 1812 at 122,000. From the census of 1830 it is stated at 240,000, which appears to be too large an allowance of inhabitants for such a small tract of a country so thinly peopled as Brazil is, considering its vast extent. (R. R. R.)

Paraiba, the name of a large river in the Brazilian province of Rio de Janeiro, which see.

PARALIPOMENA, in matters of literature, denotes a supplement of things omitted in a preceding work.

PARALLAX, in *Astronomy*, is the difference between the places of any celestial object, as seen from the surface and from the centre of the earth at the same instant. See Astronomy.

Parallax is also used to denote the change of place in any object arising from viewing it obliquely with respect to another object. Thus, the minute hand of a watch is said to have a parallax when it is viewed obliquely; and the difference between the instants shown by it when viewed directly and obliquely is the quantity of parallax in time.

PARALLEL, in *Geometry*, an appellation given to lines, surfaces, and bodies, which are everywhere equidistant from each other.

Parallel *Sphere*, that situation of the sphere in which the equator coincides with the horizon, and the poles with the zenith and nadir.

Parallel *Sailing*. See the article Navigation.

Parallels *of Latitude*, in *Astronomy*, are lesser circles of the sphere, parallel to the ecliptic, and imagined to pass through every degree and minute of the colures.

Parallels *of Altitude*, or *Almucantars*, are circles parallel to the horizon, imagined to pass through every degree and minute of the meridian between the horizon and zenith, and having their poles in the zenith.

Parallels *of Declination*, in *Astronomy*, are the same with parallels of latitude in geography.

PARALLELOPIPED, in *Geometry*, is a regular solid, comprehended under six parallelograms, the opposite ones of which are similar, parallel, and equal to each other.

PARALOGISM, in *Logic*, a sophism in reasoning, or a fault committed in demonstration, when a consequence is drawn from principles which are false, or, though true, are not proved; or when a proposition is passed over which should have been proved by the way.

PARAMARIBO, the principal town of Dutch Guiana, and capital of the province of Surinam. It is situated on the right bank of the beautiful river Surinam, about eighteen miles from its embouchure. It is about one mile and a half in length by about three quarters of a mile in breadth, and is built in the form of an oblong square. The streets are regularly laid out, and lined with orange, shaddock, tamarind, and lemon trees, which appear in perpetual bloom; whilst their branches are, at the same time, weighed down with fruit. The walks are covered with fine gravel and sea-shells, and not paved with large stones. The houses, which are generally of two stories in height, are sumptuously furnished. The rooms are seldom papered or plastered, but wainscoated with cedar, Brazilian, or mahogany wood. The town-hall is an elegant edifice, covered with tiles, the other buildings being for the most part roofed with thin split boards called shingles. In this hall the different courts are held; and underneath are the prisons for European delinquents. There is a Protestant church, a Lutheran chapel, and two Jewish synagogues, the one German, and the other Portuguese. Although not fortified, the town is defended by Fort Zelandia on the east, and by the natural defences of the river on the south-east, a large savannah on the west, and an impenetrable wood on the north-east. The citadel is separated from the town by a large esplanade, where the troops parade. There is a large and commodious military hospital. Opposite to the town the river Surinam is about a mile in breadth, and thus affords a noble road for shipping. The commerce of this town, although now surpassed by that carried on in British Guiana, is considerable; and the Dutch have made great and successful exertions to improve it. The exports are coffee, sugar, cocoa, cotton, and indigo; the imports are flour, beef, pork, herrings, salted mackerel, spermaceti candles, horses, lumber, and European manufactures. The number of inhabitants may be estimated at from 18,000 to 20,000.

PARAMATTA, a town of New Holland, on the east coast, situated at the head of Port Jackson harbour, at the distance of about eighteen miles by water and fifteen by land from Sydney. The river is for the last seven or eight miles navigable only for boats of twelve or fifteen tons burden. The town is built on a level plain, cleared of trees to a considerable extent, but not very fertile, along a small fresh-water stream which falls into the river. The streets are regularly laid out, crossing at right angles, and the town, or rather the rudiments of a town, may be said to be extensive, the inhabitants being estimated at 3000, and there being space enough for thrice that number. The dwellings are generally poor structures or wretched hovels. There are, however, a few good brick houses, to which is attached a garden, in which British vegetables are cultivated. The government buildings are very large; the governor's house is on the west side of the town, the factory for female convicts on the east, the orphan-school on the north, and the public granary on the south. An arm of the sea, about the breadth of a third-rate English river, stretches through the middle, and over it there is a bridge. There are two very good inns, with all necessary accommodations for travellers, such as are found in Great Britain. In the factory for female convicts, which is a large building, well adapted for the convenience and comfort of its inmates, there were above a hundred females when it was visited by the missionaries from the South Sea Islands, and about as many more were daily expected. They are employed in dressing and spinning flax and wool, to be woven into clothing materials by the men at their quarters. From this penitentiary the inhabitants of Sydney and Paramatta receive a supply of domestic servants, many of whom behave with perfect propriety. The orphan-school is an admirable establishment, where upwards of one hundred children of convicts are instructed in reading, writing, and arithmetic, and in moral habits. After being kept there till the age of fourteen or fifteen years, they are usually taken into families as servants or apprentices. There are also two schools for the education of the aborigines of the country, laudable institutions, but which have not yet been attended with much advantage, the natives being wedded to their native habits of ignorance and idleness, and having a rooted aversion to industry. There were in each seminary only seven boys and as many girls when it was visited by the South Sea missionaries. The schools are supported by government, an allowance of L.20 being made for each child taught. The population is chiefly composed of inferior traders, publicans, artificers, and labourers. Two fairs, held half yearly, are numerously and respectably attended. The plain on which the town is situated is cleared of trees to a considerable extent, and there is an excellent road through Paramatta; but beyond this the uncleared soil is covered with prodigious forests. Many farms, having been insulated from this tract, are divided into fields, and well cultivated, though the stumps of trees about a yard high are still seen standing amidst the corn and grass. The houses of the colonists, who follow agriculture each in his little domain, are generally clean and comfortable abodes, and some even have claims to elegance.

PARANA, a vast river of South America, originating in those mountainous ranges which traverse the Brazilian provinces of Minas Geraes and Goyas. Like the Paraguay, it is formed of a great number of small streams, the sources of which extend over several degrees, probably from the sixteenth to the twentieth of south latitude. Before the Parana reaches the parallel of south latitude under which the Paraguay commences, it has drained an immense tract of country, and become swelled to a mighty stream. About this point, which is the verge of the great table-land which forms the inner part of Brazil, it tumbles over a precipitous rocky channel, at a place called Setequedas, or Seven Falls. Some have spoken of a continued rapid and broken advance of the river for several leagues; but Cazal, a high authority, represents it as here narrowed from a league in breadth to a hundred yards, by six small rocky islands, between which the water rushes, foams, and falls. But the hundred yards mentioned must refer only to the breadth of that part of the river which is wholly uninterrupted by the islands; between all of them various minor currents must of course flow, and these are certainly not included in the statement of the width of the Parana at this part. Azara describes these stupendous cataracts under another name. The first, called Sant de Canendigu, which was the name of a cacique who inhabited this part of the country at the time of the conquest, and Sant de Guayra, from the vicinity of the province of that name, is situated not far from the tropic of Capricorn, in 24. 4. 27. of south latitude. It is a frightful cascade, and worthy of being described by the poets. Immediately before this immense river falls over the precipice, or rather inclined plane, it is suddenly contracted from above two hundred toises to about thirty toises in breadth, and descends into the frowning abyss with frightful fury, causing the solid earth to tremble around. The fall is not vertical, but at an angle of fifty degrees, the perpendicular descent being fifty-two French feet. The vapours which rise from the shock of the waters, and the pointed rocks situated in the channel of the precipice, are seen at the distance of many leagues, in the form of columns. Rainbows of the most lively colours, formed by the rays of the sun, appear suspended over the cataract; and in these a quivering movement may be perceived. The sound is heard at the distance of six leagues; and the clouds which are formed by the ascending vapours form an eternal rain in the vicinity. There are other cataracts either belonging to the Parana or its tributaries, but they are not of such magnitude as the Setequedas. The general bearing of the Parana, in by far the greater part of its course, is southerly. About the twenty-seventh parallel it takes a westerly direction, in which it continues to flow until its junction with the Paraguay. Not far from the point where it takes a great bend from south-west to nearly due west, it meets with a rocky edge, over which it is precipitated at the island of Apipé, and here navigation for large vessels terminates. But when the waters are large, the passage is free for galliotes and small craft. Near this is the lake Ibera or Ybyera, one of the most considerable in the country, and which, like the Xarayes of Paraguay, is said to be formed by the water of the upper part of the Parana. Azara, however, asserts that it has no connection with that river. It is thirty leagues in breadth at its northern extremity, where it is parallel with the Parana, and to which it is very near, though without having any visible communication with that river. Thirty leagues to the south, there is formed what has been called the Gorge of Yuquicua; after which it again enlarges in proportion as it advances southward, until it terminates by forming the river Miriñay, which is considerable, and flows into the Uruguay. From Yuquicua the lake Ybyera also stretches thirty leagues to the west, and there three rivers issue from it, called the Saint Lucie, the Corrientes, and the Bateles. It has no apparent source, receiving neither river nor rivulet, and continues during the year almost without any variation, being filled with aquatic plants, and even with some trees. A great part of it must therefore partake more of the character of a marsh than a lake; and it is to be observed that several recent authorities maintain that it is connected with the river Parana, and follows the rise and fall of its waters. "In the dry season," says Luccock, "it covers an extent of about a hundred and fifty square leagues, and all around the land supplies an abundance of food for cattle; but about a month after the rains have commenced in the upper country, that is, in December, the Ybyera swells to a vast extent, covering hardly less than two thousand square leagues. At this period it is said to communicate both with the Parana and the Uruguay; a circumstance which, if correctly stated, indicates that these streams once united there, and that the lower grounds have been formed by their concurrent operation continued for ages." Higher up on the same river, and in the midst of the woods, is another lake called the Jagape, but little more is known of it than its name, and that chiefly from the report of people dwelling in its neighbourhood, who occasionally find their way to Rio de Janeiro.

After the confluence of the Parana and Paraguay, in latitude 27. 27., the river under the former name assumes a grand and majestic appearance. It is studded with innumerable islands, some of which are of considerable size, thickly clothed with trees and shrubs, and forming a refuge for foxes, tigers, and other wild animals. The volume of its waters is of course very great. It is above two miles in breadth, of considerable depth, and has a current more rapid than that of the Paraguay before its junction. "The Parana and Paraguay," says Mr Luccock, "rolling impetuously through a very extended course, bring down a great quantity of wreck, and soil of a reddish colour. When they have arrived at the more level grounds, and their currents are become comparatively slow, much of it is deposited; there it remains until the next wet season, when it is again urged onward by a resistless torrent, which not only sweeps the bottom, but frets and tears the banks, which had before been raised." The main current is never less than two fathoms and a half in depth; and it is near the sides of the river, not in the centre, that the channel is deepest. Its periodical rise commences in December, which is some time after the commencement of the rainy season in the countries situated between the tropic of Capricorn and the equator; and it continues rising without interruption till the month of April, when decreasing till July, with somewhat more rapidity than it rose, it again shrinks within its legitimate bounds. In the latter month it is usual to perceive a slight rising, which the inhabitants of the country call "El repunte;" and which is attributed to the waters which the river receives from the streams pouring down from the temperate zone, where the season of winter is almost always rainy. But the "repunte" is of such trivial moment that it never overflows the lands even in the lowest situations. The rains, although invariable as to their recurrence, are greater in some years than in others; and the height to which the river rises, of course, corresponds with the quantity of rain which falls. The navigation of this river is of considerable importance. "There are three causes which regularly impede the navigation of rivers," says Don Ignacio Nuñez, in his work on the united provinces of the Rio de la Plata, "the great rapidity of their currents, the shallowness of their waters, and the shoals, rocks, or banks which obstruct their passage. None of these inconveniences are met with in the Parana, till reaching the island of Apipé. The rapidity of its course varies with the state of the river, and the conformation of its channel. When the rising is at its greatest height, the velocity of its current is greater than when it is on the decrease; and, in both seasons, it is always greatest in those parts where its channel is the narrowest. In the Rosario, in Punta Gorda, and in Hernan de Arias, which are the places where it is the most straitened in width, six observations made during the time of its rising gave for its average velocity a foot and a half per second. When the river is in its natural bed its stream has much less velocity, and that is not alike in all places in its breadth. In the centre of the channel it is greater than on the shore towards the bogs; and there, on account of its being very accessible, it is greater than in the places near the islands, where the velocity is almost null; which is not the case in the Rio de la Plata, in which the currents are invariably in proportion to, and in direction with, the winds which blow. It is therefore evident that the rapidity of the current of the Parana is no impediment to its navigation; which, indeed, experience has long since proved. As regards the depth, no person is ignorant of its capability for the navigation of vessels of all burdens as far as the island of Apipé; and it would continue with depth enough for that object for a great distance farther, did not a cataract situated in that place impede its progress." He then goes on to state, that its depth at the shallowest is quite sufficient for very large vessels; and that the greater part of its sinuosities and arms are not only navigable in the rainy season, but even when the river is at the lowest. "From Cape Saint Maria to the island of Apipé," he continues, "is a distance by water of five hundred leagues, navigable without any other reef than the English Bank (Banco Ingles), which will cease to be dangerous as soon as a vigilant and protecting government shall watch over the commerce and prosperity of the country. In the whole course of the Parana there is not a single stone; its bottom is clay and very fine sand; and although some banks and shallows are here and there met with, a sufficient channel is left at all times for the passage of vessels." In reference to the extent of country inundated, he says, "The average rising is about twelve feet; but the islands and lands subject to be overflowed never have that depth of water over them, owing to their greater height. When the river is at the highest, the lowest of the islands scarcely have more than three feet over them, and some, for the distance of many leagues, are covered by only eight or nine inches. There are also places which are not inundated except during extraordinary risings, which may not occur for a considerable length of time. There are likewise inundations so low that they form lakes, which disappear solely through evaporation and filtration, leaving a great quantity of fish out of their element. Calculating the immense extent of territory inundated by the Parana, only from its mouth to Cayasta, of which we can speak with accuracy from our own observations, its waters during the inundation cover about one thousand one hundred square leagues; and, making an approximate calculation of the whole extent of country which enjoys this beneficial circumstance, from near the tropic of Capricorn, where the river begins to assume this quality, to its mouth, the space participating in so vast an advantage, without any aid from art, may be reckoned at about four thousand leagues." A river so extensive as the Parana is of course supplied by many tributary rivers. Amongst the most considerable of these is the Salada or Salado, which rises in the province of Salta, and flows into the Parana at Santa Fé. It is navigable for many leagues, and as it traverses a very fertile country, it will one day become of far more importance than it is at present. It is to be distinguished from another river of the same name, which unites with the Rio de la Plata in latitude 36°, four or five degrees farther down. The Parana flows into the river last named by several mouths, comprehended between latitude 34. and 34. 20. south. Here also the Rio de la Plata receives the Uruguay, and these united streams flow majestically to the Atlantic Ocean. (R. R. R.)

PARANYMPH, amongst the ancients, the person who waited on the bridegroom, and directed the nuptial solemnities, and who was also called *pronubus* and *auspex*, because the ceremonies began by taking auspicia. As the paranymph officiated only on the part of the bridegroom, a woman called *pronuba* officiated on the part of the bride.

PARAPET, in *Fortification*, an elevation of earth designed for covering the soldiers from the enemy's cannon or small shot.

PARAPHERNALIA, or PARAPHERNA, in the civil law, those goods which a wife brings her husband besides her dower, and which are still to remain at her disposal, exclusive of her husband, unless there is some provision made to the contrary in the marriage-contract.

PARAPHRASE, an explanation of some text in clearer and more ample terms, by which is supplied what the author might have said or thought on the subject. Such are esteemed Erasmus's Paraphrase on the New Testament, the Chaldee Paraphrase on the Pentateuch, and other works of this kind.

PARAPHROSYNE, a word employed by medical writers to denote a delirium, or an alienation of mind in fevers, or from whatever other cause.

PARASANG, an ancient Persian measure, which differed at different times and in different places, being usually thirty, sometimes forty, and occasionally fifty stadia or furlongs. The word, according to Littleton, is formed from *parasch angarius*, that is, the space a postman rides from one station or *angaria* to another.

PARASCENIUM, in the Grecian and Roman theatres, was a place behind the scenes, whither the actors withdrew to dress and undress themselves. The Romans more frequently called it *Postscenium*.

PARASELENE, in *Natural Philosophy*, a mock moon; a meteor or phenomenon encompassing or adjacent to the moon, in form of a luminous ring; in which are observed sometimes one and sometimes two or more images of the moon.

PARASEMON, amongst the Greeks, was the figure carved on the prow of a ship, to distinguish it from others. This figure was generally that of a bull, lion, or other animal; sometimes the representation of a mountain, tree, flower, or other object.

PARASITE, amongst the Greeks, was originally a very reputable title, the parasites being a kind of priests, or at least ministers, of the gods, in the same manner as the *epulones* were at Rome. They took care of the sacred corn, or the corn destined for the service of the temples and the gods, viz. sacrifices and feasts; and they had even the superintendence of sacrifices, taking care that these were duly performed. At Athens there was a kind of college of twelve parasites; each tribe of Attica furnishing one, who was always chosen out of the best families. Polybius adds, that a parasite was also an honourable title amongst the ancient Gauls, and was given to their poets. But it has degenerated into a term of reproach, and is now used to signify a flatterer, sycophant, or mean dependent.

PARASITES, or Parasitical Plants, in *Botany*, such plants as are produced out of the trunk or branches of other plants, whence they receive their nourishment, and are incapable of growing on the ground. Such are the misletoe, some kinds of fungi, and others.

PARBUNCLE, in a ship, the name of a rope almost like a pair of slings. It is seized both ends together, and then put almost double about any heavy thing that is to be hoisted in or out of the ship; having the hook of the runner hitched into it to hoist it up by.

PARCÆ, in heathen mythology, goddesses who were supposed to preside over the accidents and events, and to determine the date or period, of human life. The Parcæ were three, Clotho, Lachesis, and Atropos; because, forsooth, all things have their beginning, progress, and end. Hence the poets tell us that the Parcæ spun the thread of men's lives; that Clotho held the distaff, and drew the thread; that Lachesis twirled the spindle, and spun it; and that Atropos cut it. "Clotho colum retinet, Lachesis net, Atropos secat."

But the ancients represent the Parcæ differently. Lucian delineates them in the shape of three poor old women, having large locks of wool, mixed with daffodils, on their heads; one of them holding a distaff, the other a wheel, and the third a pair of scissars, wherewith to cut the thread of life. Others represent Clotho as appearing in a long robe of variegated colours, wearing a crown upon her head adorned with seven stars, and holding a distaff in her hand; whilst Lachesis appears in a robe beset with stars, with several spindles in her hand, and Atropos clad in black, cutting the thread with a pair of large scissars. The ancients imagined that the Parcæ employed white wool for a long and happy life, and black for a short and unfortunate one.

PARCHMENT, the skins of sheep or goats prepared after such a manner as to render them proper for being written upon, or used in covering books.

The word comes from the Latin *pergamena*, the ancient name of this manufacture, which is said to have been taken from the city of Pergamus, to Eumenes, the king of which, its invention is usually ascribed; although, in reality, that prince appears rather to have been the improver than the inventor of parchment. According to Diodorus, the Persians of old wrote all their records on skins; and the ancient Ionians, as we learn from Herodotus, made use of sheep and goat skins in writing, many ages before the time of Eumenes. Nor need we doubt that such skins were dressed for the purpose, after a manner not unlike that in which our parchment is prepared, though probably not so artificially.

The manufacture of parchment is begun by the skinner, and finished by the parchment-maker. The skin having been stripped of its wool, and placed in the lime-pit, the skinner stretches it on a kind of frame, and pares off the flesh with an iron instrument. This being done, it is moistened with a rag; and powdered chalk being spread over it, the skinner takes a large pumice-stone, flat at the bottom, rubs over the skin, and thus scours off the flesh: he then goes over it again with an iron instrument, moistens it as before, and rubs it again with the pumice-stone without any chalk underneath, by which means the flesh side is very considerably smoothed and softened. He then drains it again, by passing over it the iron instrument as before. The flesh side being thus drained, by scraping off the moisture, he in the same manner passes the iron over the woolly or hairy side, and then stretches it on a frame, and scrapes the flesh side again. This finishes its draining; and the more it is drained the whiter it becomes. The skinner now throws on more chalk, sweeping it over with a piece of lamb-skin which has the wool on; and this smooths it still farther. It is then left to dry, and when dried, taken off the frame by cutting it all round. The skin, being thus far prepared by the skinner, is taken out of his hands by the parchment-maker, who first, whilst it is dry, pares it on a *summer*, or calf-skin stretched in a frame, with a sharper instrument than that used by the skinner; and, working with the arm from the top to the bottom of the skin, takes away about one half of its thickness. The skin, being thus equally pared on the flesh side, is again rendered smooth by being rubbed with the pumice-stone on a bench covered with a sack stuffed with flocks, which leaves the parchment in a condition fit for writing upon. The parings thus taken off the leather are used in making glue, size, and the like.

What is called *vellum* is only parchment made of the skins of abortives, or at least sucking calves. This has a much finer grain, and is whiter and smoother than parchment; but it is prepared in the same manner, except that it is not passed through the lime-pit.

PARDIES, Ignatius Gaston, an ingenious and learned French Jesuit, was born at Paris in 1636. He taught polite literature for several years, during which he composed, with peculiar delicacy of thought and style, small pieces both in prose and verse. At length he devoted himself entirely to mathematics and natural philosophy, and read all authors, ancient as well as modern, in those branches of knowledge. He died in the year 1673, of an infectious disorder contracted by confessing and preaching to the prisoners in the Bicêtre during the Easter holidays. Pardies published several works; but his Elements of Geometry are best known in this country, where a translation of them has gone through several editions. In 1672 he had a dispute with Sir Isaac Newton respecting the theory of light and colours, of which an account may be seen in the Philosophical Transactions for that year.

PARDON, in *Criminal Law*, is the remitting or forgiving an offence committed against the king.

Law, says Beccaria, cannot be framed on principles of compassion to guilt; yet justice, by the constitution of England, is bound to be administered in mercy. This is promised by the king in his coronation oath; and it is that act of his government which is the most personal and most entirely his own. The king condemns no man; that unpleasant task he leaves to his courts of justice; the great operation of his sceptre is mercy. His power of pardoning was said by the Saxons to be derived *a lege suæ dignitatis*; and it is declared in parliament, by stat. 27 Henry VIII. c. 24, that no other person has power to pardon or remit any treason or felonies whatsoever, but that the king has the whole and sole power thereof, united and knit to the imperial crown of this realm.

Mr Godwin, in his Inquiry concerning Political Justice, attacks this prerogative in the following terms: "What is the rule that ought in all cases to prescribe to my conduct? Surely justice; understanding by justice the greatest utility of the whole mass of things that may be influenced by my conduct. What then is clemency? It can be nothing but the pitiable egotism of him who imagines he can do something better than justice. Is it right that I should suffer constraint for a certain offence? The rectitude of my suffering must be founded on its tendency to promote the general welfare. He therefore that pardons me, iniquitously prefers the imaginary interest of an individual, and utterly neglects what he owes to the whole. He bestows that which I ought not to receive, and which he has no right to give. Is it right, on the contrary, that I should not undergo the suffering in question? Will he, by rescuing me from suffering, do a benefit to me, and no injury to others? He will then be a notorious delinquent, if he allow me to suffer. There is indeed a considerable defect in this last supposition. If, while he benefits me, he do no injury to others, he is infallibly performing a public service. If I suffered in the arbitrary manner which the supposition includes, the whole would sustain an unquestionable injury in the injustice that was perpetrated. And yet the man who prevents this odious injustice has been accustomed to arrogate to himself the attribute of clement, and the apparently sublime, but in reality tyrannical, name of forgiveness. For, if he do more than has been here described, instead of glory he ought to take shame to himself, as an enemy to the interest of human kind. If every action, and especially every action in which the happiness of a rational being is concerned, be susceptible of a certain rule, then caprice must be in all cases excluded; there can be no action which, if I neglect, I shall have discharged my duty; and if I perform, I shall be entitled to applause."

That human nature is such as in the aggregate to need control, no one who is acquainted with it will deny; and there appears to be no other method of controlling mankind but by general laws, which, through the natural imperfection of human affairs, may be cruel in one case if they are just in another. Cases may likewise occur where the sentence of the law, without its execution, will answer every purpose which could be expected from it, and where the execution of it would be extreme cruelty, although it might in strict unfeeling language be called justice, because in strict conformity with the letter of the law. Yet though such cases may and do often occur, it would be absurd to abolish any of those laws which the security of civil society has required; and therefore the only natural remedy against legal injustice is the system of pardons.

Mr Godwin next goes on to trace the origin of pardons; and instead of a definite system of law, we are told that it is necessary to have a court of reason, to which the decisions of a court of law shall be brought for revisal. But this is a remedy apparently too vague and indeterminate to produce any lasting or good effect; for the proposal of such a tribunal results from supposing mankind more virtuous and intelligent than they really are. He next proceeds to consider the abuses of pardons, whence he would draw an argument for their abolition. He tells us that the authority in this case is placed, first in the judge, and next in the king and council. "Now," says he, "laying aside the propriety or impropriety of this particular selection, there is one grievous abuse which ought to strike the most superficial observer. Those persons with whom the principal trust is reposed consider their functions in this respect as a matter purely incidental, exercise them with supineness, and in many instances with the most scanty materials to guide their judgment. This grows in a considerable degree out of the very name of pardon, which implies a work of supererogatory benevolence."

But it is obvious that pardons are in general granted in consequence of an application from people who have more than scanty materials to guide their judgments, and on whose fidelity in relating the circumstances of the case confidence is or is not placed, according to their several characters. Mr Godwin next proceeds to the arbitrary character of pardons. "Such a system," he says, "to speak it truly, is a lottery of death, in which each man draws his ticket for reprieve or execution, as undefinable accidents shall decide." The allusion here to a lottery ticket is peculiarly unfortunate, nor does the whole sentence show any great degree of candour. It is possible to define a particular crime, and to annex a particular punishment to the commission of it; but the nature of morality consists not in the external action, but in the motives which prompted to it. Definite law, however, cannot always make this distinction; and after the sentence of the law is pronounced, it comes to be considered whether there are any alleviating circumstances in the case; and whether there are or not, must depend on the particulars or accidents of the case. But it is impossible to suppose that these accidents could be previously defined; their nature does not admit of it. To particularize and define every mode of an action which imagination can conceive, or which experience has shown us may happen, would indeed be an Herculean labour; and we might literally say with the apostle, "that the world could not contain the books that might be written." We are, however, told that "reason is a thousand times more explicit and intelligible than law; and when we are accustomed to consult her, the certainty of her decisions would be such as men practised in our present courts are totally unable to conceive." Were reason, however, to be appealed to in all cases, and to be the final criterion, it would leave far greater room for villany than any mode at present in practice. Reason is a very uncertain and indefinite term, and may be made any thing, according to the circumstances or passions of men, at any given time.

We are next told that pardons are destructive to morality. "Another very important consequence," says Mr Godwin, "grows out of the system of pardons. A system of pardon is a system of unmitigated slavery. I am taught to expect a certain desirable event. From what? From the clemency, the uncontrolled, unmerited kindness of a fellow-mortal. Can any lesson be more degrading? The pusillanimous servility of the man who devotes himself with everlasting obsequiousness to another, because that other, having begun to be unjust, relents in his career,—the ardour with which he confesses the rectitude of his sentence and the enormity of his deserts,—will constitute a tale that future ages will find it difficult to understand. What are the sentiments in this respect that are alone worthy of a rational being? Give me that, and that only, which without injustice you cannot refuse. More than justice it would be disgraceful for me to ask, and for you to bestow. I stand upon the foundation of right. This is a title which brute force may refuse to acknowledge, but which all the force in the world cannot annihilate. By resisting this plea you may prove yourself unjust, but in yielding to it you grant me but my due. If, all things considered, I be the fit subject of a benefit, the benefit is merited; merit in any other sense is contradictory and absurd. If you bestow upon me unmerited advantage, you are a recreant from the general good. I may be base enough to thank you; but if I were virtuous I should condemn you. These sentiments alone are consistent with true independence of mind. He that is accustomed to regard virtue as an affair of favour and grace, cannot be eminently virtuous. If he occasionally perform an action of apparent kindness, he will applaud the generosity of his sentiments; and if he abstain, he will acquit himself with the question, May I not do what I will with my own? In the same manner, when he is treated benevolently by another, he will in the first place be unwilling to examine strictly into the reasonableness of this treatment, because benevolence, as he imagines, is not subject to any inflexibility of rule; and, in the second place, he will not regard his benefactor with that erect and unembarrassed mien, that complete sense of equality, which is the only immoveable basis of virtue and happiness."

Such being Mr Godwin's conclusion on this subject, we leave it with our readers to determine whether his system or that which we at present enjoy would be the more rigorous or unjust; or whether mankind have indeed arrived at so eminent a pitch of virtue as to disdain every favour which they do not absolutely merit. The Christian religion speaks a very different language.

PAREENUGGUR, a town of Hindustan, in the province of Cutch, and district of Parkur. It was formerly a place of great consequence, and celebrated for its temples, which were dedicated to Buddha. It now contains only 300 houses, chiefly inhabited by Sodah Rajpoots; its ancient inhabitants having long ago left it, on account of the turbulent state of the country, and migrated for safety to Noanagur and other places. The town is not fortified; and when it is attacked, the inhabitants fly for refuge to a neighbouring mountain, which is represented as rising to a great elevation. During the era of its prosperity, which was at a remote period, it was inhabited by numerous families of Banyans, whose temples were famous for elegance and sanctity, and were resorted to from every quarter for the purposes of devotion. The idol of stone, Goreecha, was an object of adoration to multitudes, who resorted thither from all quarters.

PAREGORICS, in *Pharmacy*, medicines that assuage pain, and are otherwise called Anodynes.

PARELCON, in *Grammar*, a figure by which a word or syllable is added to the end of another.

PAREMBOLE, in *Rhetoric*, a figure in which something relating to the subject is inserted in the middle of a period. According to Vossius, all the difference between the parembole and parenthesis is, that the former relates to the subject in hand, whereas the latter is foreign to it.

PARENT, a term of relation applicable to those from whom we immediately derive our being. To this subject belongs an inquiry, first, into the legal duties of parents to their legitimate children, and, secondly, their power over them.

I. The duties of parents to legitimate children consist in their maintenance, protection, and education. The duty of parents to provide for the maintenance of their children, is a principle of natural law, an obligation laid on them not only by nature herself, but by their own proper act, in bringing them into the world; for they would be in the highest degree injurious to their issue, if they only gave their children life, that they might afterwards see them perish. By begetting them, therefore, they have entered into a voluntary obligation to take care that the life which they have bestowed shall be supported and preserved. And thus the children have a perfect right to receive maintenance from their parents. The president Montesquieu justly observes upon this head, that the establishment of marriage, in all civilized states, is built on the natural obligation of the father to provide for his children, for that ascertains and makes known the person who is bound to fulfil this obligation; whereas, in promiscuous and illicit conjunctions, the father is unknown, and the mother finds a thousand obstacles in her way, shame, remorse, the constraint of her sex, and the rigour of laws, which stifle her inclinations to perform this duty; and, besides she generally wants the ability to do so.

The municipal laws of all well-regulated states have taken care to enforce this duty, though Providence has done it more effectually than any laws, by implanting in the breast of every parent that natural σοργη, or affection, which neither the deformity of person or mind, nor even the wickedness, ingratitude, and rebellion of children, can totally suppress or extinguish.

The civil law obliges the parent to provide maintenance for his child; and if he refuse, *judex de ea re cognoscet.* Nay, it carries this matter so far, that it will not suffer a parent at his death totally to disinherit his child, without expressly giving his reason for so doing; and there are fourteen reasons reckoned up, which may justify such disinherison. If the parent alleged no reason, or a bad one, the child might set the will aside, *tanquam testamentum inofficiosum,* as a testament contrary to the natural duty of the parent, by suggesting that the parent had lost the use of his reason when he made the *inofficious* testament. And this, as Puffendorff observes, was not to bring into dispute the testator's power of disinheriting his own offspring, but to examine the motives upon which he did it, and if they were found defective in reason, then to set them aside. But perhaps this is going rather too far. Every man has, or ought to have, by the laws of society, a power over his own property; and, as Grotius very well distinguishes, natural right obliges to give a necessary maintenance to children; but what is more than that they have no other right to, than as it is given by the favour of their parents, or the positive constitutions of the municipal law.

Let us next see what provision our own laws have made for this natural duty. It is a principle of law, that there is an obligation on every man to provide for those descended from his loins; and the manner in which this obligation shall be performed is thus pointed out.

The father and mother, grandfather and grandmother, of poor impotent persons, shall maintain them at their own charges, if of sufficient ability, according as the quarter sessions shall direct; and if a parent run away and leave his children, the church wardens and overseers of the parish shall seize his rents, goods, and chattels, and dispose of them towards their relief. By the interpretations which the courts of law have put upon these statutes, if a mother or grandmother marry again, and before such second marriage had sufficient ability to keep the child, the husband shall be charged to maintain it; for this being a debt of his wife when single, shall, like others, extend to the charge of the husband. But at her death, the relation being dissolved, the husband is under no farther obligation.

No person is bound to provide a maintenance for his issue, unless where the children are impotent and unable to work, either through infancy, disease, or accident; and then he is only obliged to find them in necessaries, the penalty on refusal being no more than twenty shillings a month. For the policy of our laws, which are ever watchful to promote industry, did not mean to compel a father to maintain his idle and lazy children in ease and indolence, but thought it unjust to oblige the parent, against his will, to provide them with superfluities, and other indulgencies of fortune; imagining they might trust to the impulse of nature, if the children were deserving of such favours. Yet, as nothing is so apt to stifle the calls of nature as religious bigotry, it is enacted, that if any Popish parent shall refuse to allow his Protestant child a fitting maintenance, with a view to compel him to change his religion, the Lord Chancellor shall by order of court constrain him to do what is just and reasonable. But this did not extend to persons of another religion, of no less bitterness and bigotry than the Popish; and therefore, in the very next year, we find an instance of a Jew of immense riches, whose only daughter having embraced Christianity, he turned her out of doors; and on her application for relief, it was held that she was entitled to none. But this gave occasion to another statute, which ordains, that if Jewish parents refuse to allow their Protestant children a fitting maintenance, suitable to the fortune of the parents, the Lord Chancellor, on complaint, may make such order therein as he shall see proper.

Our law has made no provision to prevent the disinheriting of children by will, leaving every man's property in his own disposal, upon a principle of liberty in this as well as every other action, although perhaps it would not have been amiss if the parent had been bound to leave them at the least a necessary subsistence. Indeed, amongst persons of any rank or fortune, a competence is generally provided for younger children, and the bulk of the estate settled upon the eldest by the marriage articles. Heirs, also, and children, are favourites of our courts of justice, and cannot be disinherited by any dubious or ambiguous words; there being required the utmost certainty of the testator's intentions to take away the right of an heir.

From the duty of maintenance we may easily pass to that of protection, which is also a natural duty, but rather permitted than enjoined by any municipal laws; nature, in this respect, working so strongly as to need rather a check than a spur. A parent may, by our laws, maintain and uphold his children in their law-suits, without being guilty of the legal crime of maintaining quarrels. A parent may also justify an assault and battery in defence of the persons of his children. Nay, where a man's son was beaten by another boy, and the father went near a mile to find him, and there revenged his son's quarrel by beating the other boy, of which beating he afterwards unfortunately died, it was not held to be murder, but only manslaughter. Such indulgence does the law show to the frailty of human nature, and the workings of parental affection.

The last duty of parents to their children is that of giving them an education suitable to their station in life; a duty pointed out by reason, and one of the greatest importance. For it is not easy to imagine that a parent has conferred any considerable benefit upon his child by bringing him into the world, if he afterwards entirely neglect his culture and education, and suffer him to grow up like a mere beast, or to lead a life useless to others and shameful to himself. Yet the municipal laws of most countries seem to be defective in this point, by not constraining the parent to bestow a proper education upon his children. Perhaps they thought it punishment enough to leave the parent who neglects the instruction of his family to labour under those griefs and inconveniences which his family, so uninstructed, will be sure to bring upon him. Our laws, though their defects in this particular cannot be denied, have in one instance made a wise provision for breeding up the rising generation, since the poor and laborious part of the community, when past the age of nurture, are taken out of the hands of their parents, by the statutes for apprenticing poor children, and are placed out by the public in such a manner as may render their abilities, in their several stations, of the greatest advantage to the commonwealth. The rich, indeed, are left at their own option whether they will breed up their children to be the ornament or the disgrace of their family.

II. The power of parents over their children is derived from the former consideration, their duty; this authority being given them, partly to enable the parent more effectually to perform his duty, and partly as a recompense for his care and trouble in the faithful discharge of it. Upon this point the municipal laws of some nations have given a much larger authority to the parents than others. The ancient Roman laws gave the father a power of life and death over his children, upon the principle, that he who gave had also the power of taking away. But the rigour of these laws was so softened by subsequent constitutions, that we find a father banished by the Emperor Hadrian for killing his son, although he had committed a very heinous crime; upon the maxim, that the *patria potestas in pietate debet, non in atrocitate, consistere.* But still they maintained to the last a very large and absolute authority; for a son could not acquire any property of his own during the life of his father; and all his acquisitions, or at least the profits of them, belonged to the father during his life.

The power of a parent by the English law is much more moderate, but is still sufficient to keep the child in order and obedience. He may lawfully correct his child, being under age, in a reasonable manner; because this is for the benefit of his education. The consent or concurrence of the parent to the marriage of his child under age was also directed by our ancient law to be obtained; but it is now absolutely necessary, for without it the contract is void. And this is also another means which the law has put into the parent's hands, in order the better to discharge his duty; first, of protecting his children from the snares of artful and designing persons; and, next, of settling them properly in life, by preventing the evil consequences of too early and precipitate marriages. A father has no other power over his son's estate than as his trustee or guardian; for although he may receive the profits during the child's minority, yet he must account for them when the child comes of age. He may indeed have the benefit of his children's labour whilst they live with him and are maintained by him; but this is no more than he is entitled to from his apprentices or servants. The legal power of a father (for a mother, as such, is entitled to no power, but only to reverence and respect) over the persons of his children ceases at the age of twenty-one; for they are then enfranchised by arriving at years of discretion, or that point which the law has established, when the empire of the father or other guardian gives places to the empire of reason. Yet till that age arrives the empire of the father continues even after his death, for he may by his will appoint a guardian to his children. He may also delegate part of his parental authority, during his life, to the tutor or schoolmaster of his child, who is then *in loco parentis,* and has such a portion of the power of the parent committed to his charge, namely, that of restraint and correction, as may be necessary to answer the purposes for which he is employed.

PARENTALIA, in *Antiquity,* funeral obsequies, or the last duties paid by children to their deceased parents.

PARENTHESIS, in *Grammar,* means certain intercalary words inserted in a discourse, which interrupt the sense, but nevertheless seem necessary for the better understanding of the subject.

PARGA, a town of Greece, situated on the coast of Albania, fourteen miles from Cape Bianco, and ten from Paxos. It is built on a conical rock about 250 feet above the level of the sea, which surrounds it on three sides, and, with a fortress on the narrow neck which joins it to the main, forms a strong post. The territory around extends two or three miles in a circle, and till 1818 was inhabited by a population of from 3000 to 4000 persons, who had cultivated the soil with equal care and success. They were mostly persons who had established themselves there in opposition to Ali Pasha, who reigned absolute master of Albania, under the nominal authority of the Grand Signior. These people wished to place themselves under the protection of the British government; but the terms upon which they stood with Ali prevented an honourable acceptance of their proposal. After some warlike demonstrations, which were followed by negotiations, Ali agreed, on the place being given up to him, to pay the large sum of L.200,000 to the inhabitants, and give them permission to leave the territory. This most of them embraced, and were removed to the islands where British protection afforded them security. Long. 20. 23. 30. E. Lat. 39. 16. 15. N.

PARHELION, or PARHELIUM, formed from παρα, *near,* and ἥλιος, *sun,* in *Natural Philosophy,* a mock sun or meteor, in the form of a very bright light, appearing on the one side of the sun.

Appearances of this kind have been mentioned both by the ancients and by the moderns. Aristotle observes, that in general they are seen only when the sun is near the horizon, though he takes notice of two which were observed in the Bosphorus from morning to evening; and Pliny has related the occasions when such phenomena appeared at Rome. Gassendi says, that in 1635 and 1636 he often saw one mock sun. Two were observed by M. de la Hire in 1689, and the same number by Cassini in 1693, Mr Grey in 1700, and Dr Halley in 1702; but the most celebrated appearances of this kind were seen at Rome by Scheiner, at Utrecht by Muschenbroeck, and at Sedan by Hevelius. By the two former four mock suns were observed, and by the latter seven.

Parhelion.

Parhelia are apparently of the same size with the sun, though not always of the same brightness, nor even of the same shape; and when a number appear at once, there is in both these respects some difference amongst them. Externally they are tinged with colours like the rainbow, and many have a long fiery tail opposite to the sun, but paler towards the extremity. Parhelia are generally accompanied with coronas, some of which are tinged with rainbow colours, but others are white. They differ in number and size; but all agree in point of breadth, which is that of the apparent diameter of the sun.

A very large white circle, parallel to the horizon, generally passes through all the parhelia; and, if it were entire, it would run through the centre of the sun. Sometimes there are arcs of lesser circles concentric to this, touching those coloured circles which surround the sun. They are also tinged with colours, and contain other parhelia. Other circles are said to have been seen obliquely situated with respect to all those we have mentioned; but of these we have met with no authentic account. The order of the colours in these circles is the same as in the rainbow; but on the inside, with respect to the sun, they are red, as is also observed in many other coronas. Parhelia have been visible for one, two, three, and four hours together; and in North America they are said to continue several days, and to be visible from sunrise to sunset.

When the parhelia disappear, it sometimes rains, or there falls snow in the form of oblong spiculæ, as Maraldi, Weidler, Krafft, and others, have observed; and in fact the air in North America abounds with such frozen spiculæ, which are even visible to the eye. According to Ellis and Middleton, such particles have been supposed to be the cause of all coronas and parhelia.

Mr Ellis says, that at Churchill, in Hudson's Bay, the rising of the sun is always preceded by two long streams of red light, one on each side of him, and about 20° distant from him. These rise as the sun rises; and as they grow longer they begin to bend towards each other, till they meet directly over the sun, just as he rises, forming there a kind of parhelion or mock sun. These two streams of light, he says, appear to have their source in two other parhelia, which rise with the true sun; and in the winter season, when the sun never rises above the haze or fog which is constantly found near the horizon, all these accompany him during the day, and set with him in the same manner as they rise. Once or twice Mr Ellis saw a fourth parhelion directly under the true sun; but this, it seems, is not common. These facts being constant, are very valuable, and may throw great light on the theory of such remarkable phenomena.

Sometimes parhelia appear in a different manner; as when three suns have been seen in the same vertical circle, well defined, and touching one another. The true sun was in the middle, the lowest touched the horizon, and they set one after the other. This appearance was seen by M. Maleziew in 1722, and others similar to it have been related by M. Musschenbroeck.

Sometimes the sun has been observed to rise or set with a luminous tail projecting from him, of the same breadth with his diameter, and perpendicular to the horizon. Such an appearance was observed by Cassini in 1672 and 1692, by De la Hire in 1702, and by Mr Ellis in Hudson's Bay. As M. Feuillée was walking on the banks of the river La Plata, he saw the sun rising over the river with a luminous tail projecting downwards, which continued till he had attained an altitude of six degrees.

Paraselenæ, or mock moons, have also been observed, accompanied with tails and coloured circles, like those which accompany the parhelia. An account of several of these, and in particular a description of a fine appearance of the same kind, may be found in Musschenbroeck.

Various hypotheses have been framed by philosophers to account for this phenomenon, more particularly by Marriotte, Descartes, and Huygens. None of these, however, seems satisfactory; but those readers who wish to become acquainted with them may consult Huygens's Dissertation on this subject, in Smith's Optics (book i. chap. xi.), Musschenbroeck's Introduction (vol. xi. p. 1038, &c. 4to); and Dr Priestley's History of Vision, Light, and Colours (vol. ii. p. 613, et seq.).

Paria.

PARIA, a province of Bolivia, in South America, situated in the department of Oruro. On the north and north-east it is bounded by the provinces of Pacajes and Oruro, on the east and south-east by Porco, on the south-west by Lipes, and on the west by Caranjas. This province is traversed by a rapid river called the Desaguadero, or Drain, which is invariably represented in maps of Peru and Bolivia as flowing into the lake of Titicaca, whilst the reverse is the fact. It issues from this celebrated sheet of water, and, after flowing a considerable distance, its waters are dissipated by spontaneous evaporation. The province of Paria is situated in a mountainous tract of country, and being very elevated, the temperature is consequently cold. Like Oruro and other provinces in this region, it is a mining district, and contains several mines of silver. There are some lakes in the province, from which salt is extracted; and also some hot springs. The lake of Paria is from three to four leagues in length and two in width, and abounds in excellent fish. Alcedo says that it has a whirlpool, which sucks down floating bodies, and finds a passage to the sea under the cordillera, and through the shore, close to the port of Iqueique. In 1748 its waters rose to an immense height, a phenomenon which Alcedo attributes to the stoppage of its subterranean passage; but this was far more likely to arise from volcanic agency, so frequent in this country, raising and depressing the land in various directions. Farming operations are carried on in Paria, but little grain is produced; the rearing of cattle, which are plentiful, chiefly occupying the attention of the inhabitants. The cheese made here of sheep's milk is esteemed a great delicacy, and is much sought after. The capital of the province, which bears the same name, is situated 210 miles west-north-west of Chuquisaca, in 18° 50′ south latitude, and 68° 20′ west longitude. The population amounts to 50,000, of which number 37,000 are Indians, and 13,000 Creoles.

Paria, *Gulf of*, a gulf of South America, situated to the north-west of the embouchure of the river Orinoco, and having on the west the province of Cumana, and on the east the large island of Trinidad. On Terra Firma, and north-west from the mouths of the Orinoco, a peninsula or neck of land projects towards the east, in the exact direction of another but much smaller neck of land which juts out from the north-western extremity of the island of Trinidad. These projections approach within a few leagues of each other, but the passage is interrupted by two or three islands, which, from their relative position, form four openings called Boccas del Drago, or the Mouths of the Dragon. Again, at the south-western extremity of Trinidad, a neck of land advances in a westerly direction, towards a part of the delta of the Orinoco, and approaches to within twelve or fourteen miles of it. This passage is likewise interrupted by islands, and is called the Serpent's Mouth. Thus the mainland embosoms an immense bay, whilst the island of Trinidad, which lies at its mouth, forms also a bay, facing the other, by its northern and southern extremities projecting forwards. Both shores thus bend and mutually approach each other, so as to form two comparatively narrow entrances, by which the waters of the gulf communicate with those of the ocean. The Gulf of Paria, at its widest part, that is, from the shores of Trinidad to those of Colombia, is eighty-three miles across. In the other direction, from the Bocca on the south to the Boccas del Drago on the north, it measures forty-three miles. In depth it varies from eight to thirty fathoms; but there is anchorage throughout its whole extent, though on the coast of Paria its soundings are much less. On the south side of the Serpent's Mouth, which communicates with the Atlantic Ocean, and receives in the rainy season the vast flood of waters which pour as from an inland ocean through the mouths of the Orinoco, a considerable current is found setting into the gulf, which is thus reported to have its waters raised four or five inches above their usual level. The surface-water at this time, which is during the months of July, August, and September, is also said to be fresh. This is by no means an unlikely circumstance, arising from the inferior specific gravity of fresh water as compared with that of the sea; and the surface of the gulf will also continue a longer time partially fresh, from its being embayed on all sides by land, so as to shut out the swell and agitation of the ocean, which would cause a more rapid commixture of the fresh and salt water. It was this current which Columbus encountered, and which gave him so unfavourable an opinion of the Gulf of Paria, which he accordingly called the Melancholy Gulf. It is of course most violent during the rainy months; but a current generally sets into the gulf through the Serpent's Mouth to the northward during the dry season; it is, however, partial and unimportant. In the months of December, January, and February the tide sets through the Dragon's Mouth from the northward, by which the current is occasionally overpowered. The water of the Gulf of Paria is generally of a turbid and dull green cast, but in the interior it presents everywhere a tranquil and glassy surface. The winds are in general light, never increasing to more than a gentle breeze, excepting in autumn, when a few transient squalls disturb its serenity. It may indeed be regarded as a spacious harbour, affording secure anchorage in all its parts, and perfectly free from gales, storms, and accidents; for if vessels happen to get aground, the soft muddy bottom receives them without injury. The nights are generally calm and quiet, the principal annoyance to the mariner being the want of wind; so that coasting along the shores of the gulf is extremely troublesome and tedious. Its waters abound with various kinds of fish; and numerous flocks of terns and pelicans may at all seasons be seen here and there, busily employed in catching their prey. The western shore of the gulf, which forms part of a province of Colombia formerly called Paria, is remarkable for its fertility and beauty. Columbus spoke with rapture of this luxuriant land, and in his enthusiasm he concluded that it was the terrestrial paradise which had received the progenitor of the human race pure from his Creator's hands. (See the article Orinoco.) The point of the peninsula, which runs for a great many leagues into the sea opposite the island of Trinidad, is called Point Paria, and is situated in latitude 9. 12. north, and longitude 62. 1. west from Greenwich.

(R. R. R.)

PARIAN Chronicle. See Arundelian Marbles.

PARIAS, or Pariahs, a tribe of Hindus, so peculiarly distinguished from all others, that they live by themselves in the outskirts of towns; and, in the country, build their houses apart from the villages, or rather have villages of their own, furnished with wells. They dare not so much as fetch water from those which other families make use of; and, lest the latter should inadvertently go to one of theirs, they are obliged to scatter the bones of dead cattle about their wells, that they may be known. See Hindustan.

PARINACOCHAS, a province of Peru, in the department of Ayachucho. It has an elevated situation in that part of the chain of the Andes which sweeps down in a circular form towards Arequipa. The temperature therefore is throughout cold, with the exception of some hollows amongst the mountains, where it is comparatively mild; and grain, herbs, and fruits, are produced in abundance. The mountains abound in mines of silver and of gold. The pasture of this province is plentiful, and of excellent quality; and numerous herds of cattle, and flocks of sheep and goats, are reared in the plains and the valleys. In the more elevated parts there are abundance of guanucas, or Peruvian camels. The chief occupations of the inhabitants consist in superintending their live stock, and manufacturing woollen cloths. In this province there is a lake called Parinacocha, seven leagues in length by about one in breadth, and in which a white bird of the name of *panuira* breeds. This name has been corrupted into Parina, and the word *cocha* or lake being added, has given rise to the designation of the province. The chief town is called Pausa, but it does not appear to be a place of any importance. The population, about 12,000 souls, is dispersed in some thirty settlements.

PARIS, the capital of France, is built on a plain watered by the river Seine, which intersects the city, and is situated in 48. 50. north latitude, and 2. 20. east longitude.

Origin and history.

The origin of Paris is enveloped in total obscurity. The first mention we find made of it is in the Commentaries of Cæsar, in whose time, about half a century before the birth of Christ, it was the chief city of the Parisii, one of the numerous Celtic tribes by whom Gaul was at that time inhabited. It was then entirely confined to the small island in the Seine now called the Cité, or the Ile du Palais. The houses which covered this small spot were, as Cæsar informs us, of the most humble order, being composed merely of mud, with straw roofs, and without chimneys. When the Gauls, then newly and but partially subdued, rose in general revolt against their Roman conquerors in the year 53 before Christ, Labienus, one of the lieutenants of Cæsar, marched against the capital of the Parisii, then called Lutetia, in the neighbourhood of which the revolted tribes had assembled in great force. An obstinate conflict ensued, and the Parisians fought with the fury of despair; but their undisciplined valour was unable to withstand the scientific tactics of the Roman legions. They were routed with great slaughter; and the general, with all his chiefs, and the greater part of his followers, were left amongst the slain. This battle appears to have been fought about four miles to the west of the Ile du Palais, but on which bank of the river the brevity of Cæsar's narrative leaves doubtful.

We find no further mention made of Paris till four hundred years after the time of Cæsar. The next notice of it is contained in the curious work of the Emperor Julian, entitled *Misopogon*, in which he speaks of having spent a winter in that town. This was in the year 358. Julian describes Paris, which he calls his dear Lutetia, as the little capital of the Parisii, and as situated on a small island rising from the river, which surrounded it on every side. It was in Paris that Julian's soldiers, two years afterwards, forced him to assume the imperial dignity, when the messengers arrived from Constans in order to recall him from the government of Gaul, which he then held. The Emperors Valentinian and Valens also passed the winter of the year 365 in Paris. Here the former issued many of his celebrated decrees; and Gratian, his son, lost, under its walls, a battle against Maximus, which cost him his empire and his life. In the year 486 this city passed from the dominion of the Romans to that of the Franks; and early in the subsequent century it was established as the capital of that people, who changed its name from Lutetia to Parisii or Parisea. Christianity had already been introduced amongst the Parisians by St Denis, about the year 250; and during the existence of the Merovingian race of princes, who governed France for a period of above two centuries and a half, numerous churches were erected, both within the city of Paris, and on the ground to the north and south of the river; whilst the buildings on the Ile du Palais, which still constituted all that was properly called Paris, were now likewise surrounded by a wall. The Merovingian race of kings was supplanted, about the middle of the eighth century, by Pepin, surnamed Le Brêf, the father of the celebrated Charlemagne. Under the Carlovingian dynasty, the extension of Paris was greatly checked by the disturbed state of the kingdom, and especially by the predatory attacks of the Normans, who, between the years 845 and 885, ravaged or besieged the city no fewer than four times. Few of the princes of the second dynasty resided at Paris, and under their feeble sway it became the patrimony of one of the great barons, who thence assumed the title of Count of Paris. Towards the close of the ninth century, it was erected into a new fief under the name of the Duchy of France; and in the year 987, Hugh Capet, who held this honour by inheritance from his ancestors, was, on the death of Louis V., elected by the other nobles to fill the vacant throne. Under the Capetian dynasty, Paris, which had now become once more the capital of France, and the principal residence of the monarch, extended itself rapidly. The ancient privileges of the citizens were confirmed, and many new immunitics were granted them. Paris, however, appears to have been without any regular municipal government until the year 1060; but Philip I., soon after his ascension to the throne, appointed a provost to maintain that superintendence over the city which had formerly been exercised by the Dukes of France. During the reign of Philip's son, Louis le Gros, the schools of Paris first acquired celebrity. For this they appear to have been principally indebted to the celebrated Abelard, whose lectures are said to have been at one time attended by no fewer than three thousand scholars. At this period many new churches were also erected; two fortresses were built at the extremities of the bridges called Le Grand and Le Petit Châtelet; and the suburbs of the city were now for the first time enclosed by a wall. In the reign of Louis VII., which extended from 1137 to 1180, the first college properly so called was founded in Paris. Various other schools and religious institutions, and several hospitals, were also established about this time. But it is to Philip Augustus, the son of Louis VII., that Paris owes many of its chief ornaments. When that monarch ascended the throne, most of the churches and other public edifices were only of wood. He rebuilt many of them of stone, and added several new ones of the same material. He provided the different parts of the city with public fountains, paved the streets, and completely surrounded the city and suburbs with a new wall. During the reigns of Francis I. and his successor, additions were made to the public buildings upon a most extensive and magnificent scale, and the city increased with such rapidity that Henry II. deemed it necessary to restrain the continued augmentation of his capital, by issuing an edict prohibiting the erection of any more houses in the suburbs, on pain of confiscation of the land and buildings. This edict was repeated at different times by succeeding monarchs, but apparently without any effect. Paris suffered severely during the wars of the League, in consequence of the hostile assaults and other calamities to which it was exposed; and many of the public buildings and houses of the nobility were laid in ruins. But these marks of civil contention were speedily effaced on the ascension to the throne of Henry IV., who was the first to embellish the city with regular squares, decorated with the different orders of architecture. Several of the unaccomplished schemes of this prince were carried into effect by his successor, Louis XIII., in whose reign the palace of the Luxembourg was built by Maria de' Medicis, and the Palais Royal by the Cardinal de Richelieu, and the celebrated Jardin des Plantes was laid out on the opposite side of the river, towards the eastern extremity of the town. During the long reign of Louis XIV. Paris was embellished by the erection of a vast number of new and splendid buildings, both public and private, and was extended in all directions. The magnificent Hôtel des Invalides was erected at the western extremity of the Faubourg St Germain. Great additions were also made to the royal palaces of the Louvre and the Tuileries. The old ditches, from the standing water of which putrid and noxious effluvia constantly arose, were filled up; the ramparts were demolished, and the present Boulevards formed in their place; and two triumphal arches were substituted for the gates of St Martin and St Denis.

The reign of Louis XV. and his successor Louis XVI. witnessed a considerable extension of Paris in various directions. Several of the adjacent villages were joined to it, and formed new faubourgs; many improvements were made in the interior of the city; numerous schools, markets, and places of public amusement, were also erected. To the taste and energy of Napoleon, Paris owes many of its most magnificent embellishments. The improvements which he added to it in the short space of twelve years surpassed those of the three preceding reigns. These consisted of twenty-four new fountains, which served at once to adorn and purify the streets; the public granaries in the garden of the arsenal; the abatoirs, many new markets and quays, four spacious cemeteries, and the Canal of the Ourcq; besides the bridges of Arts, the City, Austerlitz, and Jena. Several splendid new streets and public edifices may also be mentioned amongst the works which were either commenced or completed during his sway. The fall of that extraordinary man interrupted for a time the embellishments of Paris; but after the restoration, some works which had long been projected or begun were after many interruptions continued, and, now that they are finished, they may vie with the most useful and splendid edifices of the capital.

Situat

Paris, as has been already stated, is built on a plain on both banks of the river Seine, which at this place flows in a direction nearly from south-west to north-east. The river, as it flows through the midst of the city, is interrupted in its course by three small islands, the two most westerly of which, the Ile de la Cité, and the Ile St Louis, are covered with buildings. The third, called the Ile Louvier, is used only as a dépôt for firewood. The parts of the city on the opposite sides of the river are connected with these islands and with each other by nineteen bridges, several of which are distinguished by their elegance or splendour, and add greatly to the beauty of the city. Throughout its whole length within the barriers, the banks of the Seine are skirted on both sides with spacious stone quays, furnished with parapets, and forming two broad and continuous streets between the water and the city. These quays, thirty-four in number, not only improve greatly the appearance of the river, but also furnish an important public accommodation. They are decorated with various buildings, both public and private, and they form one of the most pleasant walks in Paris.

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Paris is nearly of a circular form. It consists of three divisions; the Ville, situated on the north, the University on the south, and the City in the centre. It stretches along the river about four miles and a half, and its breadth from the barrier St Denis to the barrier St Jacques is about three miles and a half. In the early part of the reign of Louis XVI. it was surrounded by a wall about seventeen miles in circumference, to prevent the introduction of contraband goods; but as this wall encloses a considerable space of ground which is uninhabited, and even under til-

Paris.

lage, the real extent of the city is very different from its apparent magnitude.

treets.

The impression which the general appearance of this metropolis is calculated to make upon a stranger is not of the most favourable kind. The streets in the more ancient parts, and in the centre of the city, are crooked, narrow, dark, and dirty. They are also extremely ill paved, and few of them even now possess any accommodation for foot passengers. The causeway itself is often most rugged and uneven, and is made to incline from both sides towards the centre, in order to form a run for a constant stream of black mire, there being no subterranean drains.

The general aspect of the French capital by night is singularly gloomy, so that it is almost impossible for the pedestrian to direct his steps aright. The lamps, instead of being fixed on posts at the sides of the streets, are suspended in the middle on ropes swung across, and having their opposite ends fastened to the walls of the houses. It was these ropes which the mob, in the first French Revolution, were wont to make use of as halters for their victims, and hence their well-known cry of *à la lanterne*, as they dragged them along to execution. Gas has, however, long been introduced into the shops and public buildings, and the whole city is expected in a short time to be lighted in the same manner.

Iouses.

The houses, which are generally constructed of stone, are often six or seven stories high. Their unusual height, the massive thickness of the walls, and their lower windows, which in many cases are strongly barricaded with iron, give to them an air of gloom and precaution more suited to a prison than a private dwelling. Like the buildings of the Scottish metropolis, they are inhabited by a great variety of families of all gradations of rank, from the nobleman, who occupies the first floor, to the milkman or cobler, who inhabits the garret. The whole of this motley community use the same magnificent staircase; and as the cleansing of it is the duty of no particular individual, it is often suffered to remain for months without being profaned by the mop or broom. Even when a hotel is inhabited by one family only, it is not unusual to make the upper story the receptacle for the hay and straw of the horses. Many of the larger houses do not present a simple front to the street, but only the side of one immense wing, or they are completely concealed by a high wall, erected so as to intercept the view from the street. Adjoining houses often form a complete contrast to each other in height, in workmanship, and in almost every other respect; and it not unfrequently happens that a mansion of the humblest sort, inhabited by the very meanest of the citizens, is situated beside a splendid edifice, the residence of one of the most opulent or most noble families of France.

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To the general inelegance of the streets of Paris there are, however, several remarkable exceptions. The Faubourg St Germain, in particular, contains some of the finest streets in Europe. But perhaps the most spacious and extensive street of the French metropolis is the celebrated road called the Boulevards. The northern Boulevards are twelve in number, the southern seven. They may be generally described as a road or street of great breadth, along each side of which are planted double rows of elms. Those to the north of the river are lined on both sides, throughout their whole extent, by buildings of the most handsome description. Some of these are private residences; others are shops, cafés, public hotels, and theatres. These shady avenues present a striking picture of rural beauty combined with artificial elegance and splendour. The magnificence of the buildings, the majestic trees with which the place is adorned, the winding form and great breadth of the street, and the gay and festive crowds by whom it is frequented, give to the scene singular liveliness and brilliancy, and render the Boulevards one of the most interesting and splendid spectacles which any modern city can exhibit.

Paris.

According to MM. Bérand and Dufey (*Dictionnaire Historique de Paris*), the streets of Paris, supposing all their names counted, amounted, in 1828, to 1180, besides 120 *cul-de-sacs*, 158 passages, twenty-seven alleys, thirty-two cross-ways, and seventy-four *places* or squares. There were also ten cloisters, twenty-two courts, seven enclosures, and forty-seven market-places. The town was lighted in 1830 by 4533 lamps, having 10,672 burners, exclusively of 482 lamps belonging to public establishments.

The system of numbering the houses in Paris is much more uniform and perfect than that in the British capital; and there is a peculiarity in the manner which will often prove a useful guide to the stranger. The numbers begin with that part of the street which is nearest to the Seine, or at the east end when the street is parallel with the river. The even numbers are always arranged upon the right, and the odd numbers on the left side, of the street. The numbers of the houses, and the names of the streets which are parallel with the course of the Seine, are painted in red letters, but those which are perpendicular to the Seine are in black.

Public buildings.

It is universally allowed that Paris is superior to any other European metropolis in the number and magnificence of its public buildings. The palace of the Tuileries is of comparatively modern date, and therefore possesses none of those traditions of ancient feudal tyranny and magnificence by which the palaces of European capitals are generally distinguished. This edifice derives its name from having been erected on a piece of ground appropriated to the manufacture of tiles. It was founded by the infamous Catherine de' Medicis, when her former residence, the Palace Tournelles, was destroyed by Charles IX. The land and neighbouring houses were purchased by her at a considerable expense, and the building was proceeding with great rapidity, when she became alarmed by an astrological prediction, which bade her beware of St Germain; and the Tuileries being in the parish of St Germain l'Auxerrois, the completion of the sumptuous fabric was suddenly relinquished. The palace was much enlarged by Henry IV., and the works, suspended by his death, were carried on and terminated under Louis XIII. The architects Levau and D'Orbay were employed by Louis XIV. to complete the gallery, and to harmonize the discordant masses of this extensive range of building, erected at different periods, and exhibiting various orders of architecture, differing in height and in ornament. Since then, few additions have been made to the original building of the Tuileries, but considerable changes have taken place in others dependent upon them. The front now consists of five pavilions, comprising that in the centre, with four ranges of buildings connecting them together, and forming one grand façade. The general effect of the Tuileries is exceedingly imposing; more, however, from its great length and varied outline, than from any excellence of detail. The garden front is the best, and, though heavy, and incongruous when analysed by architectural taste, is unquestionably magnificent. The view of the garden from the portico is unrivalled as a scene of artificial beauty. The eye ranges over an immense parterre, bordered with orange trees, enriched with statues, diversified by fountains and shady groves, and crowded with a pleasure-loving population. The view is continued across the beautiful walks of the Elysian Fields for a distance of several miles, and is terminated by the triumphal arch of the Barrière de Neuilly, which crowns the summit of the hill. The gardens of the Tuileries are the work of Lenôtre, the celebrated gardener of Louis XIV. They have always been accounted the chief monuments of his genius; and, indeed, they are the finest specimens in the world of their peculiar style of disposition and embellishment. They are always open to the public, and are the most fashionable promenade of Paris, both in summer and in winter.

The palace of the Tuileries was the official residence of Napoleon, and since his days it has remained the chief abode of the reigning monarch.

On the side of the Seine, the celebrated gallery of the Louvre connects that palace with the Tuileries. Of the more ancient palace, which was surrounded by ditches and flanked by massive towers, there exist no remains. That part of the edifice now known by the name of the Old Louvre was begun under Francis I., but was first inhabited by Charles IX., whose memory is associated with this palace by the infamous deed of treachery and bloodthirsty bigotry which is known by the name of the massacre of St Bartholomew. The court of the Louvre forms a square about 400 feet in extent. The buildings which surround it, having been erected at different periods, vary materially in their style of architecture and ornaments.

The principal façade, commonly called the Colonnade of the Louvre, was finished in 1670 under Louis XIV. by the celebrated architect Claude Perrault, and is unquestionably a magnificent monument of genius. The central mass of the building, forming the gateway, is crowned by a pediment, the sloping stones of which are each in a single piece, fifty-two feet in length, and three feet in thickness. The folding gates in the centre, constructed by order of Napoleon, are of bronze, and are splendidly ornamented. The general appearance of this important and interesting edifice is indisputably grand and majestic; but the narrowness of the open space in front, and the mean buildings with which it is so immediately associated, weaken the impression which it is otherwise calculated to produce. Since the reign of Louis XV. the Louvre has been devoted to the reception of the various royal museums of the fine arts, which constitute some of the principal and peculiar attractions of the capital of France. It has occasionally been used also for solemn purposes of state. During the imperial government, the palace of the Louvre was considerably repaired and embellished; and since the restoration much has been done towards its completion. It still, however, remains unfinished, in many places wanting windows, and being for the most part destitute of interior ornaments.

The Palais Royal was built by the celebrated Cardinal Richelieu, who, at his death, bequeathed it to Louis XIII. In 1692, Louis XIV. gave it to his nephew Philip of Orleans. At the time of the Revolution it was the residence of the infamous Duke of Orleans, better known by the name of Egalité, to whom it is indebted for much of its present magnificence. Having exhausted his noble revenues by a course of luxury and profligacy almost unparalleled, he determined, in order to save himself from ruin, to convert his splendid residence into an immense bazaar. The beautiful arcades of the lower galleries were divided by diminutive and ill-executed pilasters, and the garden was surrounded by a row of little shops, which were speedily let to the highest bidder. A few of the upper galleries were appropriated to the lectures of various professors, and to the meetings of literary and scientific societies; others were let to restaurateurs, but more were devoted to the accommodation of the gambler and the sensualist, and became the favourite haunt of every species of vice and debauchery. The Palais Royal has been called, not without some reason, the capital of Paris. It is certainly entered both by inhabitants and strangers more frequently than any other spot of equal dimensions in the city; and it is the perpetual rendezvous of all the idle and worthless in the capital. His present majesty, when Duke of Orleans, resided in this palace (with the exception of the interval of the "hundred days") from 1814 till 1831, making some additions and improvements in various parts of the structure, and fitting up the whole anew. At present it serves for the accommodation of foreign princes during their residence in Paris.

The palace of the Luxembourg, one of the apartments of which now forms the Chamber of Peers, is an edifice remarkable for the beauty of its proportions, and for the character of strength and solidity which it at the same time possesses. It is a square building, with an ample portico in the centre. The front consists of two large pavilions, connected together by terraces, supported by open galleries, in the centre of which rises an elegant cupola surrounded with statues. Its interior contains a splendid gallery of modern paintings.

The Palais d'Elysée Bourbon, an edifice remarkable for its luxurious elegance, was the favourite residence of Napoleon. It was to this palace that he returned after the battle of Waterloo; and here was performed the closing scene of the hurried drama of the "hundred days." After the final departure of Napoleon it was inhabited by the Duke of Wellington. It was afterwards the residence of the Duke de Berri, and on his assassination it was appropriated to the Duke de Bordeaux. It now belongs to the crown. The interesting associations connected with this small palace render it one of the most valuable public monuments of Paris.

Church

Before the Revolution, Paris contained one hundred and sixty Catholic churches or chapels. At present it does not contain more than thirty-eight, namely, twelve parish churches and twenty-six chapels of ease, thirty-five convents for women, and as many monastic seminaries. Six chapels belong to different sects, viz. three to Calvinists, one to those of the Augsburg Confession, one to the eastern Christians, and one to the Jews.

The two most important churches which the French capital exhibits are those of Nôtre Dame and the Pantheon or church of St Geneviève. The cathedral of Nôtre Dame, the mother-church of France, is a vast and magnificent building of the Gothic order, and is the most ancient religious edifice in Paris. It is 414 feet in length, 144 in width, and 102 in height, without comprehending the space allotted to forty-five chapels, and the astonishing thickness of the walls. One hundred and twenty enormous columns, which support this edifice, form a double colonnade extending the whole length of the fabric; and 297 columns, each cut from a single block, are distributed in various parts of the building. This magnificent structure is so old that the precise date of its original foundation is unknown; and its massy and venerable appearance presents a striking contrast to the modern buildings with which the city is filled.

The Pantheon, or church of St Geneviève, is perhaps the most magnificent of the modern edifices in Paris. The plan of the building is a Greek cross, forming naves which unite in a centre, surmounted by a dome of vast dimensions, which, being the highest object in Paris, is visible from any part of the city. The west portico bears some resemblance to the Pantheon at Rome, and is composed of twenty-two fluted Corinthian columns sixty feet in height and six in diameter, which support a triangular pediment a hundred and twenty feet in breadth by twenty-four in height. The pediment is now receiving some sculptures by David; and, on the frize beneath it, is the following inscription, in reference to the vaults beneath the church being used as a place of sepulture for illustrious characters:

Aux grands hommes la patrie reconnaissante.

Amongst the distinguished personages interred here are Voltaire, Rousseau, the mathematician Lagrange, Bougainville the navigator, Marshal Lannes, and the Dutch admiral De Winter. Of the other churches of Paris, those of St Sulpice, St Eustache, and St Roche, are the only ones which deserve to be particularly noticed for their size and elegance.

Paris.

The clergy of Paris are composed of one archbishop, two vicars-general appointed by the king, and nine others; three secretaries, one penitentiary, three metropolitan officials, four diocesan officials, and sixteen canons of Nôtre Dame, the first of whom is archdeacon; thirty-four honorary canons, two masters of the choristers, five superintendents of the edifice of Nôtre Dame, and three superiors of seminaries. To these must be added the curates and officiating ministers of the churches of Paris, of whom there is one to each church. The number of vicars is not accurately known, and there is also an indefinite number of almoners of hospitals, convents, and other establishments.

The total number of the Catholic clergy in France is about 41,298, including four cardinals, fourteen archbishops, and sixty-six bishops. To these may be added 10,904 theological students intended for the priesthood. The number of convents for nuns of different orders is about 3000, and the number of nuns about 24,000. There are also in France a few establishments of monks of La Trappe, and one of Carthusians or Chartreux. Of the ministers of other religious denominations there are, Lutherans, 388; reformists of the Confession of Augsburg, 345; Jews, eight; and of other denominations, eighty-six. The total expense to the state, of all religions, is 34,289,000 francs, or L.1,371,560. At the time of the Revolution the total number of ecclesiastics was 114,000, including 19,000 regular clergy, and 32,000 nuns of all orders. Their annual revenue amounted to seventy-two millions of francs, and the tithe to seventy millions, giving a total of 142 millions, or L.5,680,000 sterling.

emete-es.

The Parisians formerly buried their dead in the Roman fashion, without the city walls, along the sides of the high roads. But the increase of the population rendering it necessary to extend the bounds of the city, the cemeteries became in the process of time enclosed within the walls, and at length were almost in the heart of the town. They were so few in number, and so confined in space, that the inhabitants were thereby compelled to adopt a mode of burial altogether revolting to decency and humanity. Vast trenches were opened, into which corpse after corpse was deposited, until the putrid heap nearly reached the surface of the ground. The earth was then thrown over them, and similar trenches dug close by their side. As might have been expected, the neighbourhood of these cemeteries became proverbially the seat of every pestilential disease, till at length government interfered and prohibited all burials within the city, and ordered three cemeteries to be enclosed for the use of Paris, at a distance of about one mile from the walls. The cemeteries of Paris are now five in number. They are laid out in a picturesque style; the monuments are often in good taste, and the inscriptions are interesting. The cemetery of Père la Chaise, in particular, is one of the most beautiful as well as interesting sights of Paris. The advantageous situation of this spot upon the slope of a hill, surrounded by luxuriant valleys and rising grounds, and commanding an extensive view of a picturesque and glowing landscape, has occasioned its being chosen by the most distinguished personages as the place of their interment; and hence no Parisian cemetery can vie with that of Père la Chaise in the number and beauty of its monuments.

acombs.

In 1784, the council of state issued a decree for clearing the cemetery of the Innocents, and for removing its contents, as well as those of other cemeteries, and converting their sites into squares or market-places. The bones being separated, and carefully cleaned, were piled in some of the immense galleries of the quarries by which a great part of the city is undermined; and the name of the Catacombs was given to this new receptacle of the dead, in imitation of similar excavations appropriated to the same purpose in Rome, in Milan, in Naples, and in ancient Thebes. The calculations differ as to the number of bones collected in this vast charnel-house. It is certain, however, that it contains the remains of at least three millions of human beings.

Literary institutions.

The metropolis of France is extremely rich in literary and scientific institutions, not a few of which have obtained great celebrity. The National Institute or Royal Society is the most distinguished of these learned societies. The great reputation of this institution, and the obligations which it has conferred both on French and European science and literature, are universally acknowledged. It was established during the reign of Louis XIV. and is composed of the most distinguished philosophers, literary characters, and artists of France, and maintains a correspondence with the learned of every nation. It is divided into four classes, which may be considered as forming so many distinct societies. Each class has its separate meetings, but four times in every year the whole society assembles, and a general report is made of the labours and progress of the institution. The first division is devoted to natural philosophy, chemistry, and mathematics; the second to French literature and the French language; the third to history and ancient literature; and the fourth to the fine arts. The public meetings of the National Institute are held in a very extensive and magnificent apartment, adorned with marble statues of the most celebrated persons whom France has produced. The society of the Bureau des Longitudes is engaged in constant astronomical observations at the Observatory and in the Military School; and for this purpose it has at its disposal all the astronomical instruments belonging to government. It corresponds with the other observatories of France, and with those of foreign countries, and suggests to the government where it is desirable to establish observatories.

Seminaries.

The University of France is indebted for its origin to the illustrious Charlemagne, and has for centuries been celebrated throughout Europe. It was suppressed in 1792, but afterwards re-established on a more extensive and liberal plan. The superintendence of the business of education throughout France is now intrusted to a council, under the Minister of Public Instruction, and no school or place of instruction can be established without their permission. The university possesses a library, which is placed at the Sorbonne, and special funds are provided for granting pensions to superannuated and infirm teachers. There are many other establishments in Paris of a similar description. Of these, perhaps the most celebrated is the Royal College of France, in which there are twenty-three professors who give public and gratuitous lectures in every department of science and literature. In addition to the colleges, there are a great number of schools for special purposes founded in Paris, mostly by the government. At the head of these stands the Polytechnic School. The object of this most useful and justly celebrated institution is to diffuse the knowledge of the mathematical, physical, and chemical sciences, and to form pupils for the artillery, engineering, and other departments, into which no officer can be admitted who has not been educated in this school. The most distinguished masters in every branch of science are employed by the government. Every year a certain number of scholars are admitted, after undergoing the most rigorous examination in the classics, the mathematics, mechanics, and drawing. The number of pupils amount to three hundred. The period usually allowed for study is two years, but in certain cases it is extended to three. The school possesses an excellent philosophical and chemical apparatus, and a well-selected library, consisting of 24,000 volumes. The pupils of this establishment took a prominent part in the Revolution of 1830. In the School of Bridges and Roads, eighty pupils selected from the Polytechnic School are taught every branch of science connected with the construction of bridges, canals, harbours, roads, and public

Paris.

edifices. The museum contains a noble collection of plans, charts, and models. There is also an academy, termed the School of the Fine Arts, appropriated to the teaching of painting, sculpture, and architecture, in which lectures are given gratuitously, on every subject connected with the fine arts, by twenty professors. Besides, Paris possesses several great public schools devoted to elementary instruction; and every year is bringing improvements to this most important branch of national education. There are also many private academies; and, altogether, the institutions appropriated to the instruction of youth in the French capital are in a most flourishing condition.

Libraries.

Extensive and valuable collections of books are attached to almost every public institution and every public building in Paris. The most splendid of these collections is the Royal Library, which is justly considered as the largest and most valuable in Europe. It contains no fewer than 900,000 books and printed pamphlets, 80,000 manuscripts, 1,600,000 engravings, 300,000 maps and plans, and a most valuable collection of medals and antiquities. With a liberality highly honourable to the French character, people of every class and rank, as well as strangers from any quarter of the globe, are allowed access to it, and every necessary accommodation is provided for their use. Of the other libraries, which are extremely numerous, those of the arsenal, the Pantheon, and the Institute, are the largest and most important, and the greater part of them are open both to the Parisians and to strangers. (See the article LIBRARIES, vol. xiii. p. 285.)

Museums.

The collections of works of art, and of subjects connected with natural history, with which Paris abounds, ought not to be passed over in silence. The Museum of the Louvre, during the sway of Napoleon, was the boast of Paris, and contained almost every celebrated work of art that could be procured on the continent of Europe. On the downfall of this extraordinary man, a portion of these treasures were restored to their rightful owners; but the collection, even as it now stands, is unrivalled. The walls of the Louvre are still covered with a fine collection of pictures and statues from the Luxembourg, Versailles, and other royal residences, and partly from private collections. The paintings also which adorned the numerous churches destroyed during the frenzy of the Revolution have found an asylum in this interesting and valuable museum. The great gallery of paintings is a most magnificent apartment, 1400 feet in length, and contains upwards of 1400 pictures of the most eminent masters of every school.

Few museums are more interesting, instructive, or valuable, than the Conservatory of Arts and Trades, an immense repository of machines, models, and drawings, for the improvement of machinery and implements connected with manufactures, agriculture, and other branches of industry. It is a collection peculiar and highly creditable to the metropolis of France, and has undoubtedly been productive of the most beneficial effects in diffusing an extensive knowledge of mechanics, and a skilful adaptation of the simplest instruments to the most complicated purposes. The Museum of Artillery is a repository of every kind of warlike instrument. It likewise contains a valuable collection of the different kinds of armour used in every period of French history. The Museum of Natural History in the Jardin des Plantes stands at the head of all institutions of the kind, not only in France, but in the world. The name of Jardin des Plantes expresses very inadequately the real nature of the institution; for, in addition to a noble botanic garden, it contains a large menagerie, a museum of natural history and anatomy, and numerous halls in which public lectures are delivered on every branch of natural history and philosophy. This garden was founded by Jean de la Brosse, physician to Louis XIII.; but it is principally indebted for its present beauty and value to the assiduous labours of Buffon. From the commencement of the Revolution until the time of Napoleon, the institution was greatly neglected and abused for want of funds. But on his arriving at the head of affairs a new impulse was given to the establishment, and the only temporary check which it received was on the occupation of Paris by the allies, when a body of Prussians were about to take up their quarters in the garden; but the spirited remonstrances of the celebrated traveller Humboldt obtained a safeguard for the museum, and an exemption from all military requisitions. There was great reason to fear that the museum would be deprived of some of the valuable parts of its contents, by the restitution of the treasures which had been plundered from neighbouring countries. In fact, the magnificent cabinet of the stadtholder was reclaimed; but it was afterwards agreed that an equivalent should be furnished from the duplicates of the museum. An arrangement equally friendly and equitable was effected respecting the minerals and zoological specimens which had been taken from the Austrian dominions in Italy. Since that time the support of this museum has been munificently provided for by the state, and its condition was never so flourishing as at the present moment. Its collections of every kind are equally valuable and rare. The garden and the menagerie contain specimens of almost every living production of the animal or the vegetable kingdom, arranged with great taste and skill. For the cabinet of comparative anatomy, incomparably the richest in existence, the museum is indebted to the unwearied exertions of Baron Cuvier, by whom it was arranged, and under whose direction most of the objects were prepared. The cabinet of natural history is equally precious, and still more complete. In the zoological and fossil departments it is unrivalled; and one of the halls contains some interesting specimens of the animal remains of the antediluvian world, with the skeletons of numerous animals now unknown or extinct. There are various other institutions of a similar kind in Paris, of which the Royal Museum at the Luxembourg, and the Cabinets of Mineralogy and Anatomy, are the most extensive and celebrated.

Monuments.

Of the public monuments the greatest is the column in the Place Vendome, erected under the superintendence of Denon, in commemoration of the campaign of 1805, upon the model of Trajan's Pillar at Rome. It is 134 feet high by twelve feet in diameter, formed of the metal of 425 brass cannon taken from the Austrians and Prussians in that campaign. It was originally surmounted by the statue of Napoleon, which was removed in 1814, and replaced in 1831. The triumphal arch in the Place du Carousel, built on the plan of that of Septimius Severus at Rome, is not inferior to its celebrated original. In 1806 a triumphal arch of surpassing magnitude was commenced at the extremity of the principal avenue of the Champs Elysées; but after it had attained a considerable elevation it was stopped by the reverses of the Russian campaign. Our limited space forbids our describing other monuments highly deserving of notice, such as the gate of St Denis, the gate of St Martin, the equestrian statue of Henry IV., the obelisk on the heights of Chaillot, &c.

Hospit

The hospitals and charitable institutions of Paris are remarkably numerous and extensive. They are supported and maintained by government, and are under the direction of a general council and an administrative committee, consisting of some of the most distinguished functionaries of the state, the principal magistrates, and others remarkable for their talents and philanthropy.[1] According to the report published by the prefect of the department in 1834, the hospitals, thirteen in number, contained 5337 beds, and the hospices, eleven in number, 11,740 beds, giving a total of 17,077 beds. The number of patients in the hospitals on the 1st of January 1833 was 4170, in the hospices 9567; and the number admitted during the year was, in the former 61,765, in the latter 3190; giving a total in hospitals and hospices for 1833 of 78,692. On the first of January of the same year, there were supported by the hospices 17,433 foundlings and orphans; and to these were added during the year 5693 foundlings, whilst 1760 children were placed out gratuitously to nurse, and 68,986 persons were relieved at home by the Bureau de Bienfaisance; thus giving a general total of persons supported and assisted by public charity during that year, of 172,564. The proportion of the number of indigent persons in Paris to that of the whole population is as one to eleven; and the number of the indigent families relieved was 31,723. According to the same account, the total expenditure, in 1833, of the hospitals and charitable institutions dependent on them was 10,186,388 francs. The mean time of a patient's remaining in the hospital was twenty-three days, and the average cost of each patient was thirty-eight francs. The number of deaths in the hospitals was 5886, giving a mean mortality of one in eleven. In the hospices, the cost of each patient per day was eighteen sous, the number of deaths 1548, and the mean mortality about one in six. The number of the foundlings was 23,126, and the cost of supporting each was seventy-four francs. There is a board of medical men, called the Bureau Central d'Admission, established for the inspection of persons desiring to be admitted into the hospitals when the case is not one of urgency. The particular hospital is indicated by this board to the patient, according to the nature of the complaint; and no one can be admitted into any without an order from its members.

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[1] The name of Hospitals is generally appropriated to the establishments for the sick, and that of Hospices to those in which children and the aged and infirm are received.

At the head of the charitable institutions of Paris stands the Hôtel des Invalides. This magnificent edifice, which has been termed the Chelsea Hospital of France, was erected by Louis XIV. for the reception and maintenance of disabled and superannuated soldiers. The buildings are very extensive, and, with the adjoining grounds, which are tastefully adorned with long alleys of trees, cover a space of nearly seventeen acres.

This excellent institution is under the direction of the minister of war. The governor is a marshal of France; and under him there are a lieutenant-general, commandant of the hotel, and a colonel called colonel-major. The establishment is capable of containing 7000 persons, but at present there are not above 3500 in it; and even this number is likely to be considerably diminished, in consequence of the long continuance of peace. Skilful physicians are attached to it, and the Sisters of Charity nurse the sick with the greatest care. These old warriors find in this asylum abundant and wholesome food, every attention to their infirmities and wounds, and pay proportioned to the rank they held in the army. The officers and privates have separate refectories, and those above the rank of captain dine in their own rooms. They all wear the same uniform, and whenever the king comes within their walls they have the exclusive privilege of guarding his person. Their only duty is to mount guard at the hôtel and its dependencies. The interior was embellished by cannon taken at various periods by the armies of France. A considerable number of banners are ranged along both sides of the nave of the church. They are mostly Spanish and Portuguese; but amongst them there is a large collection of Algerine standards, all won on the field of battle. In the time of Napoleon nearly 3000 flags filled the nave; but on the evening before the entry of the allied armies into Paris in 1814, the Duke de Feltre, minister of war, by order of Joseph Bonaparte, commanded them to be burned, that they might not fall into the hands of the enemy.

The Hôtel Dieu, which is the oldest hospital in Paris, is unfortunately situated in the most populous part of the city. It was formerly very crowded and inconvenient, but has received great improvements since the Revolution. It comprises at present twelve wards for men and eleven for women, containing altogether 1260 beds. There are many other institutions in Paris of a charitable and benevolent nature, which are all conducted on the most liberal principles, and of late years they have undergone very considerable improvements.

Savings' Bank.

There is also an excellent institution called the Caisse d'Epergne et de Prevoyance, intended as a kind of savings' bank, which deserves to be noticed for the important benefits it has conferred upon the industrious classes. The administration is gratuitous, being defrayed out of money with which it was endowed by the original founder. Deposits of from one to fifty francs are received, and four per cent. compound interest is allowed on them. Not more than 2000 francs can be kept by any individual in this bank, and the whole or part of the deposits may be withdrawn on giving five days' notice. The total amount of money paid into the establishment during the year 1835 was 24,085,174 francs, divided amongst 150,000 depositors. It is gratifying to learn, that the importance and utility of this most benevolent institution are extending every year.

Courts.

The Minister of Justice is the supreme head of all the courts in the kingdom, and keeper of the seals. To him belongs the organization and superintendence of the whole judicial system, and of the body of notaries.

The courts of justice in France are now comprehended under three grand divisions, viz. the Tribunaux de Première Instance, the Cours Royales, and the Cour de Cassation. There are, besides, several special courts, such as the Tribunaux de Commerce, the Cour de Comptes, and the Officialités or Ecclesiastical Courts.

The Cour de Cassation, which is held in the Palais de Justice, is the supreme court of appeal from all the tribunals of France. It can alter the decisions or judgments of any court or tribunal, and there is no appeal from its decrees. It can censure the royal courts, summon the judges to render an account of their conduct, and even suspend them from the exercise of their functions. The Court of Cassation is composed of a president, three vice-presidents, and forty-five councillors, nominated for life by the king, and is divided into three sections, called sections of requests, and of civil and criminal cassation.

The Cour des Comptes, or Court of Exchequer, is the court next in rank to that of Cassation, and enjoys the same prerogatives. It takes cognizance of all matters relating to the revenue, and examines all the principal accounts of the kingdom. For the despatch of business it is divided into three sections or chambers, each of which has a president and six conseillers-maîtres.

The Cour Royale consists of a president, five vice-presidents, and numerous other officers. It is divided into five chambers; three for civil actions, one for appeals from the correctional police, and another for accusations or indictments.

The Tribunal de Première Instance is divided into eight chambers; five for civil affairs, and the others for affairs of the correctional police, and all offences relative to the customs, indirect taxes, excise, &c.

The judges of the Tribunal of Commerce are respectable merchants, principally heads of ancient houses, who are nominated in a general assembly of merchants, subject to the approbation of the king.

The order of advocates is very numerous, and justly celebrated for their talent and learning. They have a bureau

Paris.

for gratuitous advice to the poor, at their library in the Palais de Justice.

The number of notaries in Paris who exercise their profession within the jurisdiction of the Royal Court is 114. They give security to the government, and on their retirement or death their places are sold.

Municipal government and police.

The chief officer of the municipality of Paris is the prefect of the Seine, who may be said to exercise the functions both of what we should call lord-lieutenant of the county or department, and of mayor of the city. Under him is a council of prefecture, composed of five members, and also a secretary-general. The council-general of the department consists of forty-four members, three of whom are elected by each arrondissement of Paris, and four by each rural arrondissement. Each of the twelve arrondissements into which the city is divided has its particular municipality, presided over by a mayor and a justice of the peace, and four commissaries of police, one for each of its quarters. Besides the prefect of the department, who resides at the Hôtel de Ville, there is also the prefect of police, whose residence is in the Ile de la Cité, and who exercises his authority in subordination to the minister of the interior. The police of Paris has been brought to a state of great perfection, and such is the immense number of clerks, officers, and spies employed, and so strict is the system of espionage, that they possess the most minute information respecting the character and pursuits of every suspected person; indeed their secret agents, chosen from all classes of society, and paid accordingly, are to be found in almost every public assembly.

Prisons.

The prisons of Paris were at one time as wretched in their accommodations, and as unhealthy, as those of any city in Europe. Immediately before the Revolution, considerable progress was made in improving them; but in 1795, the National Convention ordered a report to be drawn up respecting the state of the prisons; and in the following year a criminal and penal code was formed, which fixed with greater precision the competency of the different tribunals, and separate prisons were appointed for the different classes of offenders. The changes effected in the criminal legislation since the Revolution have necessarily produced a great improvement in the prison regulations; and the new buildings lately erected for such purposes promise to produce the most beneficial results, not only to the prisoners, but also to the community at large. The prisons existing in Paris are now eight in number, and the persons confined in them are divided into the following classes; those under accusation, debt, or political offenders, and offenders liable to only one year's imprisonment; persons under trial, persons condemned to hard labour, juvenile criminals, and females; all of which are under the jurisdiction of the prefect of police. Besides, there are three military prisons, under the jurisdiction of the minister of war.

Trade and manufactures.

Commerce and manufactures have by no means attained that degree of prosperity which we might be led to expect from the size, population, and facilities of the city. The staple manufactures of the French capital consist chiefly of articles of taste, and all kinds of fancy works, such as jewellery, watches, artificial flowers, toys, and the like. There are no authentic returns published of the produce of the different manufactures of Paris, calculated to the present day. An immense increase has, however, taken place within the last ten years, and is still proceeding very rapidly. The prefect of the department, in his report of 1834, estimates the manufactures of Paris exported to foreign countries at eighty millions of francs annually, and those for the consumption of the departments at the same amount. Of the manufacturing establishments of Paris, two belong to the government; namely, those for tapestry and carpets, and for snuff. The first of these, known by the name of the Gobelins, from a dyer who instituted it about the middle of the sixteenth century, manufactures that beautiful tapestry, the reputation of which has spread over all Europe. The principal subjects on which the looms are employed are copies of the most celebrated pictures of the French and Italian schools; for brilliancy of colour, fidelity of outline, and delicacy of execution, their productions are often little inferior to the most masterly touches of the pencil. Of the other manufactures of the capital, paper-hangings, leather, jewellery, chemical products, gas, fine hardware, fans, &c. give occupation to a vast number of persons, and yield considerable profits. Printing, engraving, and the preparation of all substances and materials connected with the fine arts, form very extensive branches of trade.

As every thing which enters Paris must be introduced by the Barriers, where duties are levied upon almost all descriptions of necessaries as well as luxuries, the quantities of the different articles of consumption used by the population every year are ascertained with extraordinary exactness. The following is a table of the consumption of the town of Paris during the year 1834, extracted from the *Annuaire du Bureau des Longitudes*.

Wine	877,769	hectolitres.
Brandy	35,716	...
Cider and perry	16,390	...
Vinegar	19,275	...
Beer	120,552	...
Grapes	1,569,356	kilogrammes.
Oxen	72,474	head.
Cows	14,175	...
Calves	70,739	...
Sheep	364,409	...
Pigs	85,336	...
Pies, preserved meats, &c.	1,122,466	kilogrammes.
Meat, coarse	2,553,422	...
Sausages, hams, salt pork, &c.	643,495	...
Offal	1,062,873	...
Cheese, dry	1,150,187	...
Sea-fish	4,229,388	francs.
Oysters	1,118,971	...
Fresh-water fish	307,949	...
Poultry and game	7,728,041	...
Butter	10,301,762	...
Eggs	4,441,384	...

The ordinary consumption of Paris in grain and flour is estimated at 158 sacks, each weighing 139 kilogrammes, daily, or 91,695,300 kilogrammes annually. The price of the loaf of household bread, of four pounds weight, varies from eleven to twelve sous. The annual consumption of potatoes in Paris is nearly 325,000 kilogrammes, or about 650,000 pounds. More than twenty cart loads of water-cresses are brought into Paris daily, each of which produces 300 francs, thus giving a daily consumption of 6000 francs for this article alone.

Taxes.

Indirect taxes produce on an average nineteen millions a year. The post-office collects annually in Paris alone about four millions and a quarter. The direct taxes amounted, in the year 1815, to about twenty-two millions; but at present they amount to twenty-eight millions. The revenues of the city of Paris for the year 1835 were 44,436,797 francs, and the expenditure for the same year was about 41,087,091 francs. During the year 1835 the sum of 6,286,000 francs was devoted by the municipality to the embellishment of the town; a similar sum of 6,615,000 francs was allotted to the same purpose for the year 1836; and the budget of the town for the year 1835 was expected to give a clear excess of 4,782,004 francs, to be devoted to improvements and embellishments. The total territorial revenue of the Seine, in 1835, amounted to about 54,418,000 francs. The produce of the octroi duties has been gradually increasing for some time past; in 1834 it amounted to 27,684,000 francs, and in 1835 to 29,050,000 francs. The average annual duties paid for the navigation of the Seine amount to about 700,000 francs.

The following are the official returns of the population of Paris.

	1789.	1801.	1811.	1821.	1831.	1836.
Paris	524,186	546,856	622,636	713,966	774,338	909,126
Saint-Denis	5,330	4,425	6,500	8,236	9,686	9,352
Sceaux	1,000	1,404	1,500	1,349	1,459	1,670
Total	530,516	552,685	630,636	723,551	785,483	920,148

The above numbers are exclusive of strangers and troops, which are never comprehended in these returns.

In the department of the Seine the numbers in 1836 were 1,106,891.

	Men.				Women.			
	Children and Unmarried.	Married Men.	Widowers.	Total.	Children and Unmarried.	Married Women.	Widows.	Total.
Paris	268,933	174,080	16,513	459,526	223,080	172,895	53,625	449,600
Saint Denis	28,026	23,804	2,419	54,249	26,244	23,672	5,892	55,808
Sceaux	25,904	17,967	1,739	45,610	19,670	17,863	4,565	42,098

All ranks of the inhabitants are distinguished by gay and agreeable dispositions, and great civility of manners. The polished character of Parisian society throws a veil of external decency over the more disgusting features of immorality. The eyes and the ears are not offended, as in London or Edinburgh, with the rudeness and blackguardism of vice; but the statistics of Paris indicate that, under the thin covering of superficial decency and civility, there lies a deep substratum of criminality and corruption.

The number of suicides in Paris is very great; on the other hand, the executions are few. These were, in

	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.
Suicides	261	279	307	269	359	369	325	360	394
Executions	3	1	6	1	1	1	2	0	4

being an average of suicides of rather more than 346 for the last six years; whilst the capital punishments for the same period are on an average one and a half annually.

The laws for licensing and regulating female licentiousness, so far from checking the progress of corruption, seem rather to foster it. Every prostitute is compelled to take out a license at the proper bureau, for which she pays a stipulated sum. Her name, her age, and her abode, are entered in the books of the police; and once in every month she is visited by a medical man appointed for the purpose, who gives her, or withholds, according to circumstances, a *carte de santé*, or bill of health. Should she dare to pursue her calling without this license and this medical certificate, she is liable to fine, imprisonment, and corporal punishment. Some notion of the actual number of these females in Paris may be formed from the following table of the number of inscriptions during twenty years, which is abridged from the work of M. Perent Duchâtelet, whose benevolent exertions to prevent and restrain this frightful social evil deserve the warmest gratitude of all who are sincerely concerned in the welfare and improvement of the human race.

	Annual Total.	Monthly Average.
1813	20,113	1676·08
1815	22,249	1854·08
1820	32,957	2746·41
1825	31,483	2623·58
1826	29,948	2495·66
1827	29,663	2471·91
1828	31,956	2663·00
1829	34,118	2843·16
1830	36,337	3028·08
1831	39,128	3260·66
1832	42,699	3558·25

It thus appears that in 1832 the total number of females inscribed or registered as public prostitutes amounted to above 42,000, and the average monthly inscriptions were above 3500. As the population of the French metropolis was at the period referred to upwards of 800,000, the estimate now given makes the number of public females spending their lives in and subsisting by prostitution to be rather more than one in twenty of the whole population.

In 1834, the total number of births was 29,104, deaths 23,015, marriages 8091. Of the 29,104 births, 9985 were illegitimate, and of these, 4523 took place in hospitals and public institutions, and 3649 were recognised by the fathers. 14,023 persons died at their own houses, 7759 in civil hospitals, 895 in military hospitals, fifty in prisons, and 288 were deposited at the Morgue.[1] In the returns of the population of Paris for 1835, the births were,

	Boys.	Girls.	Total.
Legitimate	12,725	12,056	24,781
Illegitimate	5,476	5,297	10,773

Marriages 581. Deaths, males 15,519, females 14,587; deposited at the Morgue, males 226, females, forty-two; total 30,332. Of the foundlings who are every year received into the hospitals, above twenty per cent. die annually. According to the experience of a century and a half, the months in which the greatest mortality prevails in Paris are March and April, and the least August and July. The greatest number of children are born in March and January, the smallest in June, November, and December. The greatest number of marriages take place in May, the smallest in March and January. The number of male births exceeds that of females, on the average of the last seventy-seven years, in the proportion of nearly twenty-six to twenty-five. For the whole of France, the proportion is sixteen males to fifteen

females in the case of legitimate children, and as twenty-three to twenty-two for illegitimate children. Of the population of Paris, it has been calculated that nearly one half are working and labouring people, the rest being occupied in some trade or profession, or living upon their income. There are 80,000 servants, and nearly the same number of paupers. Nearly 15,000 patients are always in the hospitals, and about four times that number pass through the hospitals in the course of the year. There are about 20,000 foundling children supported by the state, and nearly the same number of aged and infirm incapable of working. The population of the prisons is generally about 4000.

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[1] The Morgue is a small building where unknown and unclaimed corpses found by the police are left to be recognised by their friends. A window is constructed so as to enable those who look through it to see distinctly the bodies deposited in it; and it rarely happens that the passenger who turns aside to look will not be shocked with the view of one or more corpses on the floor.

Paris, *Matthew*, one of our best historians, but of whose life few particulars have been transmitted to us. Leland, his original biographer, without determining whether he was born in France or in England, informs us that he was a monk of St Alban's, and that he was sent by Pope Innocent to reform the monks of the convent at Holm in Norway. Bishop Bale, the next in point of time, adds, that, on account of his extraordinary gifts of body and mind, he was much esteemed, particularly by Henry III., who commanded him to write the history of his reign. Fuller represents him as a native of Cambridgeshire, because there was an ancient family of his name in that county, and also mentions his being sent by the pope to visit the monks in the diocese of Norwich. Bishop Tanner, Bishop Nicholson, Doctor Dupin, and the *Nouveau Dictionnaire Historique*, add not a single fact to those we have just related. Matthew Paris died in the monastery of St Alban's in the year 1259. He was doubtless a man of extraordinary knowledge for the thirteenth century; possessing an excellent moral character, and, as an historian, exhibiting strict integrity. His style is unpolished; but that defect is sufficiently atoned for by the honest freedom with which he relates the truth, regardless of the dignity or sanctity of the persons concerned. His works are, 1. Historia ab Adamo ad Conquestum Angliæ, lib. i. manuscript, col. C. C. Cantab. c. ix. Most of this book is transcribed, by Matthew of Westminster, into the first part of his *Florilegium*. 2. Historia Major, seu Rerum Anglicanarum Historia a Gul. Conquestoris adventu ad annum 43 Henrici III., several times printed. The first part of this history, viz. to the year 1235, is transcribed almost verbatim from the Chronicle of Roger Wendover; and the appendix, from the year 1260, is the work of William Rashinger, who was also a monk of St Alban's. 3. Vitæ Duorum Offarum, Merciæ regum, S. Albani fundatorum. 4. Gesta xxii. Abbatum S. Albani. 5. Additamenta Chronicorum ad Historiam Majorem. 6. Historia Minor, sive Epitome Majoris Historiæ, in manuscript. Paris left several works in manuscript.

Paris, the son of Priam, king of Troy, by Hecuba, and also named *Alexander*. He was decreed, even before his birth, to become the ruin of his country; and when his mother, in the first months of her pregnancy, had dreamed that she should bring forth a torch which would set fire to her palace, the soothsayers foretold the calamities which were to be expected from the imprudence of her future son, and which would end in the ruin of Troy. Priam, to prevent so great and so alarming an evil, commanded his slave Archelaus to destroy the child as soon as he was born. But the slave, either touched with humanity, or influenced by Hecuba, did not obey, and was satisfied with exposing the child upon Mount Ida, where the shepherds of the place found him, and educated him as their own. Some attribute the preservation of his life, before he was found by the shepherds, to the motherly tenderness of a she-bear, who suckled him. Paris, though educated amongst shepherds and peasants, gave very early proofs of courage and intrepidity; and from his care in protecting the flocks of Mount Ida from the rapacity of the wild beasts, he was named the "helper or defender." He gained the esteem of all the shepherds; whilst his graceful countenance and manly deportment recommended him to the favours of Œnone, a nymph of Ida, whom he married, and with whom he lived in the most perfect tenderness. Their conjugal peace, however, was not of long duration. At the marriage of Peleus and Thetis, the goddess of discord, who had not been invited to partake of the entertainment, showed her displeasure by throwing into the assembly of the gods who were at the celebration of the nuptials, a golden apple, on which were written the words *Detur pulchriori*. All the goddesses claimed it as their own, and the contention at first became general; but at last only three, Juno, Venus, and Minerva, wished to urge their respective claims to the prize, in virtue of superior beauty. The gods, unwilling to become arbiters in so delicate an affair, appointed Paris to adjudge the prize of beauty to the fairest of the goddesses; and indeed the shepherd seemed sufficiently qualified to decide so great a contest, as his wisdom was so well established, whilst his prudence and sagacity were also known. The goddesses appeared before their judge without any covering or ornament, and each endeavoured by promises and entreaties to gain the attention of Paris, and to influence his judgment. Juno promised him a kingdom, Minerva military glory, and Venus the fairest woman in the world for his wife. After he had heard their several claims and promises, Paris adjudged the prize to Venus, and gave her the golden apple, to which perhaps she seemed entitled as the goddess of beauty. This decision of Paris drew upon the judge and his family the resentment of the other two goddesses.

Soon afterwards Priam proposed a contest amongst his sons and other princes, and promised to reward the conqueror with one of the finest bulls of Mount Ida. His emissaries were sent to procure the animal, and it was found in the possession of Paris, who reluctantly yielded it. The shepherd, anxious to regain his favourite, went to Troy and entered the lists of the combatants. He was received with the greatest applause, and obtained the victory over his rivals, Nestor the son of Neleus, Cyenus the son of Neptune, Polites, Helenus, and Deiphobus, sons of Priam. He likewise obtained a superiority over Hector, who, enraged to see himself conquered by an unknown stranger, pursued him closely; and Paris must have fallen a victim to his brother's rage, had he not fled to the altar of Jupiter. This sacred retreat preserved his life; and Cassandra, the daughter of Priam, struck with the similarity of the features of Paris to those of her brothers, inquired his birth and age. From these circumstances, she soon discovered that he was her brother, and as such she introduced him to her father and to her brothers. Priam acknowledged Paris as his son, forgetful of the alarming dreams which had caused him to meditate his death: and all jealousy ceased amongst the brothers. Paris did not long suffer himself to remain inactive; he equipped a fleet, as if willing to redeem Hesione, his father's sister, whom Hercules had carried away and obliged to marry Telamon the son of Æacus. This was the pretended motive of his voyage, but the real causes were far different. Paris remembered that he was to be the husband of the fairest of women; and, if he had been led to form these expectations whilst he was an obscure shepherd of Ida, he had now every plausible reason to see them realized, since he was the acknowledged son of the king of Troy. Helen was the fairest woman of the age, and Venus had promised her to him. On these grounds, therefore, he went to Sparta, the residence of Helen, who had married Menelaus. He was received with great respect; but he abused the hospitality of Menelaus, and whilst the husband was absent in Crete, Paris persuaded Helen to elope with him, and to fly to Asia. Helen consented; and Priam received her into his palace without difficulty, as his sister was then detained in a foreign country, and as he wished to show himself as hostile as possible to the Greeks. This affair was soon productive of serious consequences. When Menelaus had married Helen, all her suitors had bound themselves by a solemn oath to protect her person, and therefore the injured husband reminded them of their engagements, and called upon them to recover her. Upon this all Greece took up arms in the cause of Menelaus; Agamemnon was chosen general of the combined forces, and a regular war commenced. Paris, meanwhile, who had refused Helen to the petitions and embassies of the Greeks, armed himself, with his brothers and subjects, to oppose the enemy; but the success of the war was neither hindered nor promoted by his means. He fought with little courage, and at the very sight of Menelaus, whom he had so recently injured, all his resolution vanished, and he retired from the front of the army, where he walked before like a conqueror. In a combat with Menelaus, which he undertook at the instigation of his brother Hector, Paris must have perished, had not Venus interfered, and stolen him from the resentment of his antagonist. In another battle, however, he wounded Machaon, Euryphilus, and Diomedes; and, according to some opinions, he killed with one of his arrows the great Achilles himself.

The death of Paris is differently related. Some say that he was mortally wounded by one of the arrows of Philoctetes, which had been once in the possession of Hercules; and that, when he found himself becoming languid on account of his wounds, he ordered himself to be carried to the feet of Œnone, whom he had basely abandoned, and who in the years of his obscurity had foretold him that he would solicit her assistance in his dying moments. But he expired before he came into the presence of Œnone; and the nymph, still mindful of their former loves, threw herself upon his body, and stabbed herself to the heart, after she had plentifully bathed it with her tears. According to others, Paris did not immediately proceed to Troy when he left the Peloponnesus, but was driven upon the coasts of Egypt, where Proteus, king of that country, detained him; and when he heard of the violence which had been offered to the king of Sparta, he kept Helen at his court, and permitted Paris to retire. Whatever was the mode of his death, it is said to have taken place about 1188 before Christ.

PARISH, the precinct of a parochial church, or a circuit of ground inhabited by people who belong to one church, and are under the particular charge of its minister. The word comes from the Latin *parochia*, and the Greek παροικια, *habitation*, compounded of παρα, *near*, and οικος, house. Accordingly, Du Cange observes, that the name παροικια was anciently applied to the whole territory of a bishop, because the primitive Christians, not daring to assemble openly in cities, were forced to meet secretly in the neighbouring houses.

In the ancient church there was one large edifice in each city for the people to meet in; and this they called *parochia*, or parish. But the signification of the word was afterwards enlarged, and by a parish was meant a diocese, or the extent of the jurisdiction of a bishop, consisting of several churches; unless we suppose, as some do, that those bishops were only pastors of single churches. Dupin observes, that country parishes were unknown before the fourth century; but those of cities are more ancient. The city of Alexandria is said to have been the first which was divided into parishes.

Of the first division of parishes there is no certain information; for in the early ages of Christianity in this island, parishes were unknown, or at least signified the same thing as diocese. There was then no appropriation of ecclesiastical dues to any particular church; but every man was at liberty to contribute his tithes to any priest or church that he pleased; or if he made no special appropriation of them, they were paid to the bishop, whose duty it was to distribute them amongst the clergy, and for other pious purposes, according to his own discretion. Camden says that England was divided into parishes by Archbishop Honorius, about the year 630. Sir Henry Hobart maintains that parishes were first erected by the council of Lateran, held in the year 1179. But Selden proves that the clergy lived in common, without any division of parishes, long after the time mentioned by Camden; and it appears from the Saxon laws, that parishes were in being long before the council of Lateran in 1179. The distinction of parishes first occurs in the laws of Edgar, about the year 970. It seems pretty certain, says Justice Blackstone (Com. vol. i. p. 112), that the boundaries of parishes were first ascertained by those of a manor or manors; because it very seldom happens that a manor extends itself over more than one parish, although there are often many manors in one parish. As Christianity spread, the lords began to build churches upon their own demesnes or wastes, in order to accommodate their tenants in one or two adjoining lordships; and, that they might have divine service regularly performed therein, they obliged all their tenants to appropriate their tithes to the maintenance of the one officiating minister, instead of leaving them at liberty to distribute them amongst the clergy of the diocese in general. The tract of land the tithes of which were thus appropriated formed a distinct parish; a circumstance which accounts for the frequent intermixture of parishes one with another. For if a lord had a parcel of land detached from the main part of his estate, but not sufficient to form a parish of itself, it was natural for him to endow his newly-erected church with the tithes of such lands.

Parish-Clerk. In every parish the parson, vicar, or curate has a parish-clerk under him, who is the lowest officer of the church. Parish-clerks were formerly clerks in orders, and their business at first was to officiate at the altar, for which they had a competent maintenance by offerings; but they are now laymen, and have certain fees at christenings, marriages, and burials, besides wages for their maintenance.

PARK (French *parque*, that is, *locus inclusus*) is a large extent of ground enclosed and privileged for wild beasts of chase, by the king's grant or prescription.

Manwood defines a chase a privileged place for beasts of venery, and other wild beasts of the forest and chase, *tam sylvestres quam campestres*. A park, therefore, differs from a chase or warren in this, that it must be enclosed; for if it lie open, this is a good cause of seizure by the king, as a thing forfeited.

Park, *Mungo*, a celebrated traveller, was born at Fowlshiels, near Selkirk, on the 10th of September 1771. His father occupied the farm of Fowlshiels, under the Duke of Buccleuch. He appears to have bestowed uncommon attention on the education of his children; and he even employed a tutor to reside in his house, an expense which was then supposed to exceed the resources of an ordinary farmer. Young Park made a good figure at school. His general demeanour was reserved and thoughtful; yet occasional sparks of ambition broke forth, indicative of that adventurous spirit which lay concealed under a somewhat cold exterior. This thoughtful disposition led his friends to consider the church as the profession best suited to his character; but as he himself preferred physic to theology, his wishes were acquiesced in; and he spent three years at the University of Edinburgh, in the studies necessary to qualify him for that profession.

At Edinburgh Park studied with ardour and success; and in particular he imbibed a fondness for botany, which served to give a strong colour to his future life. It strengthened his natural connection with his brother-in-law, Mr

James Dickson, who, notwithstanding many disadvantages, attained such skill in that science, that, on going as a gardener to Hammersmith, he obtained a large share of the patronage and favour of Sir Joseph Banks. This connection induced Mr Park to repair to London. He was introduced to Sir Joseph, who was so much pleased with him that he obtained for him the appointment of assistant-surgeon to the Worcester East Indiaman. In this capacity Mr Park performed a voyage to Bencoolen, where he made some collections and observations in botany and natural history, which were submitted to the Linnæan Society, and an account of them printed in the third volume of their Transactions.

The African Association were now anxiously looking out for a successor to Major Houghton, their unfortunate missionary, who had perished in the attempt to penetrate to the Niger and Timbuctoo. This opening, although foreign to any of Mr Park's former pursuits except that of natural history, was immediately embraced by him with an ardour which showed how congenial it was to the character of his mind. Without hesitation, he offered himself for this arduous and perilous service, and, being supported by the recommendation of Sir Joseph Banks, he was at once accepted.

Park spent about two years in and near London, acquiring the qualifications necessary for his mission. In May 1795 he set sail, and on the 21st of June following arrived at Jillifree, near the mouth of the Gambia. After spending some months with Dr Laidley at Pisania, in acquiring the Mandingo language, he, on the 2d of December 1795, departed on his grand expedition. It would be superfluous to enter here into a detail of events which are so generally known, and which excited so deep an interest, as his captivity amongst the Moors, his almost miraculous escape, his discovery of the course of the Niger, and of the African capital of Sego, his journey through Bambarra, and the train of peril and difficulty through which he effected his return. He arrived, after the length of his absence, and the want of intelligence respecting him, had nearly extinguished all hopes of his safety. Reaching London early in the morning of Christmas 1797, he went to pass the time before breakfast in the gardens of the British Museum, where, by a singular chance, he met Mr Dickson, who embraced his friend as one returned from the grave. An extraordinary interest in his adventures was immediately excited amongst the African Institution, its friends, and the public in general. Major Rennell drew up an important memoir, showing the new light thrown by his journey upon African geography, which, with an abstract of his narrative by Mr Bryan Edwards, was speedily offered, to satisfy the curiosity of the public. In the spring of 1799, Mr Park presented the public with a full narrative from his own pen. Major Rennell's memoir was appended, and a considerable part of Mr Edwards' abstract was incorporated verbatim; upon which circumstance alone seems to have been built the rumour of that gentleman having been the actual writer of the volume. The work was read with an avidity proportioned to the novelty and importance of the information contained in it, and to the interesting and agreeable manner in which the events were narrated.

Having finished this task, Mr Park seems to have resolved to retire into domestic and professional life. In 1799, he married Miss Anderson of Selkirk, daughter of the gentleman with whom he had served his apprenticeship as a surgeon. In October 1801, he embraced an opportunity which offered, of commencing a professional career at Peebles, and soon found himself in respectable practice. His situation now seemed sufficiently comfortable, being happy in domestic life, possessed of a competence, and surrounded by respectable society; but his active mind was not to be so satisfied, and was secretly panting after a higher sphere of exertion.

Important as were his discoveries, their effect had been, not to satisfy, but to excite still farther, the public curiosity. The course of the Niger through the unknown and central parts of the continent could not fail to excite peculiar interest. This was strongly felt, not only by the scientific world, but by some intelligent members of administration, who, on the conclusion of the peace in 1801, determined to fit out an expedition on a great scale, to effect the discovery of the termination of this great river. In autumn 1803, Lord Hobart, afterwards Earl of Buckinghamshire, who was then colonial secretary, offered the command of it to Mr Park, who, though he asked a short interval to consult his friends, seems never in his own mind to have hesitated as to its acceptance. To those who represented to him the dangers that were to be incurred, he urged, that the hardships attendant on the obscure exercise of his profession, his journeys to distant patients, his long and solitary rides over "cold and lonely heaths," and over "gloomy hills, assailed by the wintry tempest," would tend as effectually to shorten life as the journey now in contemplation.

In this new undertaking, Mr Park was amply supplied with every thing which could insure success. Thirty soldiers, and nearly the same number of carpenters and artificers, were placed under his command; arms, beasts of burden, and commodities to trade with, were amply supplied; and he was empowered to draw upon the treasury to the extent of L.5000. Everything, therefore, seemed to augur a still more brilliant issue to his present than to his former journey. But a dark destiny impended over it, and rendered abortive all human means and efforts.

It would be superfluous to enter into a detail of that afflicting train of events, with which the public are already but too well acquainted.[1] That Park perished in his voyage down the Niger, may be considered as long since fully established; and we need not swell our pages with the rumours which have been circulated respecting an event which has for many years ceased to be doubtful.

Park has been pronounced by some the first of modern travellers. Without altogether adopting this opinion, we may observe, that the problem of the course of the Niger, which he had the fortune partially to solve, was one which had involved in error almost all former geographical systems on Africa. D'Anville, indeed, had stated it correctly; but as he had not communicated the grounds upon which his conclusion rested, the opposite opinion, which represented the Niger as flowing westward, and joining the ocean by the channel of the Senegal, continued still prevalent. This point, finally decided, fixed the geographical character of the continent. In Bambarra, also, a name as yet scarcely heard of by Europeans, Park found a kingdom much farther advanced in populousness and civilization than had yet been supposed to exist in the heart of Africa.

Mr Park's literary, though not equal to his active qualifications, were nevertheless respectable. But notwithstanding his knowledge of botany, he cannot be considered as a scientific traveller. We see not in him that varied and splendid science which, in Humboldt, illustrates and adorns, though it sometimes overlays the main subject. But with arker.

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[1] The Narrative of this journey was published in 1815, in 4to, with a very interesting biographical memoir and preface, by Mr Wishaw. It may not be amiss to notice here a singular oversight in Park's Journal, lately observed by M. Walckenaer. A 31st day is counted in April (p. 7); and as all the days before and after are accounted for, there can be no doubt that all the following dates are one day behind. This, as Mr Bowdich has shown, is not so trifling an error as at first sight it appears; for a false declination being thus taken, an error, greater or less, and sometimes not inconsiderable, is committed in the calculation of all the subsequent latitudes.

Parkur || Parliament.

regard to the general aspect of nature, and the forms of human society, his observations are careful, accurate, and judicious. Nothing can be more lively than the idea which we receive from him of the African forests and deserts, the cities of Bambarra, the stream of the Niger or Joliba, and the regions watered by that river. The spirit, joined to the unpretending simplicity, of his narrative, has rendered his work one of the most popular of its kind in the English language.

Mr Park's bodily frame was well fitted for the arduous enterprises in which he engaged. He was six feet in height, his limbs were well proportioned, and his whole frame was active and robust. His countenance was prepossessing, and his manners always retained their native plainness and simplicity. But this was combined with a natural coldness and reserve, which rendered his conversation less interesting than was expected by those who considered his general talents and extensive opportunities of observation. His conduct in all the relations of private life was highly exemplary. He left a widow, three sons, and a daughter. (E.)

PARKER, MATTHEW, the second Protestant archbishop of Canterbury, was born at Norwich in the year 1504, the 19th of Henry VII. His father, who was a man in trade, died when his son was about twelve years of age; but his mother took especial care of his education, and at the age of seventeen sent him to Corpus Christi College, Cambridge, where, in 1523, he took his bachelor's degree. In 1527 he was ordained, created master of arts, and chosen fellow of the college. Having obtained a license to preach, he frequently discoursed at St Paul's cross in London, and in other parts of the kingdom. In the year 1533 or 1534, he was made chaplain to Anne Boleyn, who obtained for him the deanery of Stoke Clare in Suffolk, where he founded a grammar-school. After the death of this unfortunate woman, Henry made him his own chaplain, and in 1541 appointed him prebendary of Ely. In 1544, he was, by the king's command, elected master of Corpus Christi College, and the following year appointed vice chancellor of the university. In 1547 he lost the deanery of Stoke, by the dissolution of that college. In the same year he married the daughter of Mr Robert Harlestone, a Norfolk gentleman.

In the year 1552 he was nominated by Edward VI. to the deanery of Lincoln, which, with his other preferments, enabled him to live in great affluence. But Mary had scarcely succeeded to the throne when he was deprived of every office he held in the church, and obliged to live in obscurity, frequently changing his place of abode to avoid the fate of the other reformers.

Elizabeth ascended the throne in 1558; and in the following year Parker was at once raised from indigence and obscurity to the see of Canterbury, an honour which he had neither solicited nor desired. In this high station he acted with equal spirit and propriety. He founded several scholarships in Bennet or Corpus Christi College, Cambridge, and made large presents of plate to that and to other colleges in this university. He gave a hundred volumes to the public library; and, besides, founded a free school at Rochdale in Lancashire. He took care to have the different sees filled with pious and learned men; and, considering the great want of Bibles in many places, he, with the assistance of other learned men, improved the English translation, which he caused to be printed on large paper, and dispersed throughout the kingdom. This estimable prelate died in the year 1575, aged seventy-two, and was buried in his own chapel at Lambeth. He was pious without affectation or austerity, cheerful and contented in the midst of adversity, moderate in the height of power, and beneficent beyond example. He was the author of several works, and likewise published four of our best historians; Matthew of Westminster, Matthew Paris, Asser's Life of King Alfred, and Thomas Walsingham. The archbishop also translated the Psalter. This version was printed, but without a name, and has been attributed to an obscure poet of the name of Keeper. Such, at least, was Wood's opinion, although it is more than probable that he was wrong. But in the Gentleman's Magazine for 1781 (p. 566), Parker is proved to be the author of a version of the Psalms.

PARKUR, a small district of Hindustan, situated about the twenty-fourth degree of north latitude. This part of the country has been seldom visited by Europeans, but is described by the natives as of a sandy and rocky nature, ill supplied with water. It has to the north the sandy desert, to the south Cutch, to the east Gujerat, and to the west the province of Sinde. There is no cultivation, except by means of irrigation from wells or tanks. The territory is said to contain between forty and fifty villages.

PARLEY, a conference with an enemy. To beat or to sound a parley is therefore to give a signal for holding such a conference, by beat of drum or sound of trumpet.

PARLIAMENT, the grand assembly of the three estates of the kingdom, summoned together by the king's authority, to consider of matters relating to the public welfare, and particularly to enact and repeal laws.

The original institution of parliament is one of those matters which lie so far hidden in the obscurity of antiquity, that the tracing of it out is a task difficult in itself, and not likely to be productive of any satisfactory result. The term *parliament* itself is comparatively of modern date, being derived from a French word, and signifying the place where they met and conferred together. It was first applied to general assemblies of the states under Louis VII. in France, about the middle of the twelfth century. But it is certain that, long before the introduction of the Norman language into England, all matters of importance were debated and settled in the great council of the realm; a practice which seems to have been universal amongst the northern nations, particularly the Germans, and which was carried by them into all the countries of Europe which they overran at the dissolution of the Roman empire. Relics of this constitution, under various modifications and changes, are still to be met with in the diets of Poland, Germany, and Sweden.

In England, however, this general council has been held immemorially, under the several names of *michel-synoth*, or great council; *michel-gemote*, or great meeting; and more frequently *wittena-gemote*, or the meeting of wise men. It was also styled in Latin, *commune concilium regni, magnum concilium regis, curia magna, conventus magnatum vel procerum, assisa generalis*, and sometimes *communitas regni Angliæ*. We have instances of its meeting to order the affairs of the kingdom, to make new laws and to amend the old, or, as Fleta expresses it, *novis injuriis emersis nova constituere remedia*, as early as the reign of Ina king of the West Saxons, Offa king of the Mercians, and Ethelbert king of Kent, in the several realms of the heptarchy. But, after their union, the Mirrour informs us that Alfred ordained as a perpetual usage, that these councils should meet twice in the year, or oftener if need be, to treat of the government of God's people, and how they should keep themselves from sin, live in quiet, and receive right. The succeeding Saxon and Danish monarchs held frequent councils of this sort, as appears from their respective codes of laws, the titles of which usually indicate that they were enacted, either by the king with the advice of his *wittena-gemote* or wise men, as, *Hæc sunt instituta, quæ Edgarus rex consilio sapientium suorum instituit*; or by those sages with the advice of the king, as, *Hæc sunt judicia quæ sapientes consilio regis Ethelstan instituerunt*; or, lastly, by both together, as, *Hæ sunt institutiones, quas rex Edmundus et episcopi sui cum sapientibus suis instituerunt.*

There is also no doubt that these great councils were occasionally held under the first princes of the Norman line. Glanvil, who wrote in the reign of Henry II. speaking of the particular amount of an amercement in the sheriff's court, says it had never yet been ascertained by the general assize or assembly, but was left to the custom of particular counties. Here the general assize is spoken of as a meeting well known, and its statutes or decisions are referred to in manifest contradistinction to custom or to the common law. And in the time of Edward III. an act of parliament, made in the reign of William the Conqueror, was pleaded in the case of the Abbey of St Edmund's Bury, and judicially allowed by the court.

Hence it indisputably appears that parliaments or general councils were coeval with the kingdom itself. How those parliaments were constituted and composed is another question, which has been matter of great dispute amongst our learned antiquaries; and, particularly, whether the Commons were summoned at all, or, if summoned, at what period they began to form a distinct assembly. But without entering into controversies of this kind, it may be sufficient to observe here, that it is generally agreed, that, in the main, the constitution of parliament, as it now exists, was marked out as long ago as the seventeenth year of King John, 1215, in the Great Charter granted by that monarch, in which he promises to summon all archbishops, bishops, abbots, earls, and greater barons, personally, and all other tenants in chief under the crown, by the sheriff and bailiffs, to meet at a certain place, upon forty days' notice, to assess aids and scutages when necessary. And this constitution subsisted at least from the year 1266, or the 49th of Henry III., there being still extant writs of that date, to summon knights, citizens, and burgesses, to attend parliament. We proceed therefore to inquire wherein consists this constitution of parliament as it now stands; and, in the prosecution of this inquiry, we shall consider, first, the manner and time of its assembling; secondly, its constituent parts; thirdly, the laws and customs relating to parliament; fourthly, the methods of proceeding, and of enacting statutes, in both houses; and, lastly, the manner of the parliament's adjournment, prorogation, and dissolution.

1. The parliament is to be regularly summoned by the king's writ or letter, issued out of chancery, by advice of the privy council, at least forty days before it begins to sit. It is a branch of the royal prerogative that no parliament can be convened by its own authority, or by the authority of any excepting the king alone; and this prerogative is founded upon very good reason. For, supposing it had a right to meet spontaneously, without being called together, it is impossible to conceive that all the members, and each of the houses, would agree unanimously upon the proper time and place of meeting; and if half of the members met, and half absented themselves, who could determine which was really the legislative body, the part assembled, or that which staid away? It is therefore necessary that the parliament should be called together at a determinate time and place, and it is highly becoming its dignity and independence that it should be called together by none but one of its own constituent parts; but, of the three constituent parts, this office can only appertain to the king, as he is a single person, whose will may be uniform and steady, the first person in the nation, being superior to both houses in dignity, and the only branch of the legislature which has a separate existence, and is capable of performing any act at a time when no parliament is in being. Nor is it an exception to this rule, that, by some modern statutes, on the demise of a king or a queen, if there be then no parliament in being, the last parliament revives, and is to sit again for six months, unless dissolved by the successor; for this revived parliament must have been originally summoned by the crown.

It is true indeed that the Convention Parliament, which restored Charles II., met above a month before his return, the Lords by their own authority, and the Commons in pursuance of writs issued in the name of the keepers of the liberty of England by authority of parliament; and that the said parliament sat till the 29th of December, fully seven months after the Restoration, and enacted many laws, several of which still remain in force. But this was from the necessity of the case, which supersedes all law; for if they had not so met, it would have been morally impossible that the kingdom could have been settled in peace. The first thing, however, which was done after the king's return, was, to pass an act declaring this to be a good parliament, notwithstanding the defect of the king's writ; so that as the royal prerogative was chiefly wounded by their so meeting, and as the king himself, who alone had a right to object, consented to waive the objection, this cannot be drawn into an example in prejudice of the rights of the crown. Besides, we should also remember, that there existed at that time great doubt amongst the lawyers, whether even this healing act made it a good parliament; and indeed it was held by many in the negative, though this seems to have been too nice a scruple. But, out of abundant caution, it was thought necessary to confirm its acts in the next parliament, by statute 13 Car. II. c. 7 and c. 14.

It is likewise true, that at the time of the Revolution in 1688, the Lords and Commons, by their own authority, and upon the summons of the Prince of Orange, afterwards William III., met in a convention, and therein disposed of the crown and kingdom. But it must be remembered, that this assembling was held upon a similar principle of necessity as at the Restoration, that is, upon a full conviction that James II. had abdicated the government, and that the throne was thereby vacant; and this supposition of the individual members was confirmed by their concurrent resolution when they actually came together. In such a case as the palpable vacancy of a throne, it follows, *ex necessitate rei*, that the form of the royal writs must be laid aside, otherwise no parliament could ever meet again. For let us put another possible case, and suppose, for the sake of argument, that the whole royal line should at any time fail and become extinct, which would indisputably vacate the throne; in this situation it seems reasonable to presume that the body of the nation, consisting of Lords and Commons, would have a right to meet and to settle the government. But upon this and no other principle did the Convention assemble in 1688. The vacancy of the throne preceded their meeting without any royal summons, and was not a consequence of it. They did not assemble without writ, and then declare the throne vacant; but, the throne being previously vacant by the king's abdication, they assembled without writ, as they must have done if they assembled at all. Had the throne been full, their meeting would not have been regular; but, as it was really empty, such meeting became absolutely necessary. Accordingly, it is declared by statute (1 William and Mary, stat. i. c. 1), that this Convention was really the two houses of parliament, notwithstanding the want of writs, or other defects of form; so that, notwithstanding these two capital exceptions, which were justifiable only on a principle of necessity, and each of which, by the way, induced a revolution in the government, the rule laid down is in general certain, that the king only can convoke a parliament.

And this, by the ancient statutes of the realm, he is bound to do every year, or oftener if need be. Not that he is, or ever was, obliged by these statutes to call a new parliament every year; but only to permit a parliament to sit annually for the redress of grievances, and the despatch of business, if need be. These last words are so loose and vague, that such of our monarchs as were inclined to govern without parliaments neglected the convoking of them, sometimes for a very considerable period, under pretence that there was not need of them. But, to remedy this, by the statute 16 Car. II. c. 1, it is enacted, that the sitting and holding of parliaments shall not be intermitted above three years at the most; and by the 1st of William and Mary, stat. ii, c. 2, it is declared to be one of the rights of the people, that, for the redress of all grievances, and for the amending, strengthening, and preserving of the laws, parliaments ought to be held frequently. And this indefinite frequency is again reduced to a certainty by statute 6 William and Mary, c. 2, which enacts, as the statute of Charles II. had before done, that a new parliament shall be called within three years after the determination of the former.

2. The constituent parts of a parliament are, the king's majesty, sitting there in his royal political capacity; and the three estates of the realm—the Lords Spiritual, and the Lords Temporal, who sit together with the king in one house, and the Commons, who sit by themselves in another. The king and these three estates taken together form the great corporation or body politic of the kingdom, of which the king is said to be *caput, principium, et finis.* For upon their assembling, the king meets them, either in person or by representation, without which there can be no beginning of a parliament; and he alone possesses the power of dissolving them.

It is highly necessary, for preserving the balance of the constitution, that the executive power should be a branch, though not the whole, of the legislature. The total union of them, we have seen, would be productive of tyranny; the total disjunction of them, for the present, would in the end produce the same effects, by causing that union against which it seems to provide. The legislature would soon become tyrannical, by making continual encroachments, and gradually assuming to itself the rights of the executive power. Thus the long parliament of Charles I., whilst it acted in a constitutional manner, with the royal concurrence, redressed many heavy grievances, and established many salutary laws. But when the two houses assumed the power of legislation, exclusively of the royal authority, they soon afterwards assumed the reins of administration; and, in consequence of these united powers, overturned both church and state, and established a worse oppression than any they pretended to remedy. To prevent any such encroachments, the king is himself a part of the parliament; and as this is the reason of his being so, the share of legislation which the constitution has placed in the crown consists in the power of rejecting rather than resolving, this being sufficient to answer the end proposed. For we may apply to the royal negative, in this instance, what Cicero observes of the negative of the Roman tribunes, that the crown has not any power of doing wrong, but merely of preventing wrong being done. The crown cannot begin of itself any alterations in the established law; but it may approve or disapprove of the alterations suggested and consented to by the two houses. The legislature, therefore, cannot abridge the executive power of any rights which it now has by law, without its own consent, since the law must perpetually stand as it now does, unless all the powers agree to alter it; and herein consists the true excellence of the British government, that all its parts form a mutual check upon each other. In the legislature, the people are a check upon the nobility, and the nobility a check upon the people, by the mutual privilege of rejecting each what the other has resolved; whilst the king is a check upon both, which preserves the executive power from encroachments. But this very executive power is again checked and kept within due bounds by the two houses, through the privilege they possess of inquiring into, impeaching, and punishing the conduct of evil and pernicious counsellors. Thus every branch of our civil polity supports and is supported, regulates and is regulated, by the rest. For the two houses naturally drawing in two directions of opposite interest, and the prerogative in another different from them both, they mutually keep each other from exceeding their proper limits; whilst the whole is prevented from separation, and artificially connected together, by the mixed nature of the crown, which is part of the legislature, and the sole executive magistrate. Like three distinct powers in mechanics, they jointly impel the machine of government in a direction different from what either, acting by itself, would have done; but at the same time in a direction partaking of each separate impulsion, and formed out of all, constituting the true line of the liberty and happiness of the community.

3. The power and jurisdiction of parliaments, says Sir Edward Coke, is so transcendent and absolute, that it cannot be confined either for causes or persons within any bounds; and of this high court, he adds, it may be truly said, *Si antiquitatem spectes, est vetustissima; si dignitatem, est honoratissima; si jurisdictionem, est capacissima.* It has sovereign and uncontrollable authority in making, confirming, enlarging, restraining, abrogating, repealing, reviving, and expounding laws, concerning matters of all possible denominations, ecclesiastical or temporal, civil, military, maritime, or criminal; this being the depository where that absolute power, which must in all governments reside somewhere, is intrusted by the constitution of these kingdoms. All mischiefs and grievances, operations and remedies, which transcend the ordinary course of the laws, are within the reach of this extraordinary tribunal. It can regulate or new-model the succession to the crown, as was done in the reigns of Henry VIII. and William III. It can alter the established religion of the land, as was done in a variety of instances in the reigns of Henry VIII. and his three children. It can change and create afresh even the constitution of the kingdom and of parliaments, as was done by the act of Union, and the several statutes for triennial and septennial elections. It can, in short, do every thing that is not naturally impossible; and therefore some have not scrupled to call its power, by a figure rather too bold, the "omnipotence of parliament." True it is, however, that what the parliament does, no authority upon earth can undo; so that it is a matter most essential to the liberties of this kingdom, that such members be delegated to this important trust as are most eminent for their probity, their fortitude, and their knowledge. For it was a known apophthegm of Lord Treasurer Burghley, that England could never be ruined but by a parliament; and, as Sir Matthew Hale observes, this being the highest and greatest court, over which none other can have jurisdiction in the kingdom, if by any means a misgovernment should anyway fall upon it, the subjects of this kingdom are left without any manner of remedy. To the same purpose Montesquieu, though we trust too hastily, presages, that as Rome, Sparta, and Carthage, have lost their liberty and perished, so the constitution of England will in time lose its liberty and perish; it will perish, says he, whenever the legislative power shall become more corrupt than the executive.

To prevent the mischiefs which might arise by placing this extensive authority in hands that are either incapable or unfit to manage it, it is provided by the custom and law of parliament, that no one shall sit or vote in either house, unless he be twenty-one years of age. This is also expressly declared by statute 7 and 8 William III. c. 25. With regard to the House of Commons, doubts have arisen, from some contradictory judgments, whether or not a minor was incapacitated from sitting in that house. It is also enacted by statute 7 Jac. I. c. 6, that no member shall be permitted to enter the House of Commons till he has taken the oath of allegiance before the Lord Steward or his deputy; and by 30 Car. II. st. ii., and 1 Geo. I. c. 13, it is provided that no member shall sit or vote in either house, till he has, in the presence of the house, taken the oaths of allegiance, supremacy, and abjuration, and subscribed and repeated the declaration against transubstantiation, the invocation of saints, and the sacrifice of the mass. Aliens, unless naturalized, were likewise by the law of parliament incapable of serving therein; and it is enacted by statute 12 and 13 William III. c. 2, that no alien, even though he be naturalized, shall be capable of being a member of either house of parliament. But these are not the only standing incapacities. If any person be made a peer by the king, or elected to serve in the House of Commons by the people, yet may the respective houses, upon complaint of any crime committed by such person, and proof thereof, adjudge him disabled and incapable to sit as a member; and this by the law and custom of parliament.

For as every court of justice has laws and customs for its direction, some the civil and canon, some the common law, others their own peculiar laws and customs, so the high court of parliament has also its own peculiar law, called the *lex et consuetudo parliamenti;* a law which, Sir Edward Coke observes, is *ab omnibus quærenda, a multis ignorata, a paucis cognita.* It will not therefore be expected that we should enter into the examination of this law with any degree of minuteness; since, as the same learned author assures us, it is much better to be learned from the rolls of parliament and other records, and by precedents and continual experience, than can be expressed by any one man. It will be sufficient to observe, that the whole of the law and custom of parliament has originated from this one maxim, "that whatever matter arises concerning either house of parliament, ought to be examined, discussed, and adjudged in that house to which it relates, and not elsewhere." Hence, for instance, the Lords will not suffer the Commons to interfere in settling the election of a peer in Scotland; the Commons will not allow the Lords to judge of the election of a burgess; nor will either house permit the subordinate courts of law to examine the merits of either case. But the maxims upon which they proceed, together with the method of proceeding, rest entirely in the breast of the parliament itself, and are not defined or ascertained by any particular or stated laws.

The privileges of parliament are likewise very large and indefinite; and therefore, when in the 31st of Henry VI. the House of Lords propounded a question to the judges concerning them, the chief justice, Sir John Fortescue, in the name of his brethren, declared, "That they ought not to make answer to that question; for it hath not been used aforetime that the justices should in anywise determine the privileges of the high court of parliament; for it is so high and mighty in its nature that it may make law, and that which is law it may make no law; and the determination and knowledge of that privilege belong to the lords of parliament, and not to the justices." Privileges of parliament were principally established in order to protect its members, not only from being molested by their fellow-subjects, but more especially from being oppressed by the power of the crown. If therefore all the privileges of parliament were once to be set down and ascertained, and no privilege to be allowed but what was so defined and determined, it were easy for the executive power to devise some new case not within the line of privilege, and under pretence thereof to harass any refractory member, and to violate the freedom of parliament. The dignity and independence of the two houses are therefore in a great measure preserved by keeping their privileges indefinite. Some, however, of the more notorious privileges of the members of either house are, privilege of speech, of person, of their domestics, and of their lands and goods. As to the first, the privilege of speech, it is declared by the statute 1 William and Mary, st. ii. c. 2, as one of the liberties of the people, "that the freedom of speech, and debates, and proceedings in parliament, ought not to be impeached or questioned in any court or place out of parliament;" and this freedom of speech is particularly demanded of the king in person by the speaker of the House of Commons at the opening of every new parliament. So likewise are the other privileges of person, servants, lands, and goods, which are immunities as ancient as Edward the Confessor, in whose laws we find this precept: *Ad synodos venientibus, sive summoniti sint, sive per se quid agendum habuerint, sit summa pax;* and so too in the old Gothic constitutions, *Extenditur hæc pax et securitas ad quatuordecim dies, convocato regni senatu.* This formerly included not only privilege from illegal violence, but also from legal arrests and seizures by process from the courts of law; and still to assault by violence a member of either house, or his menial servants, is a high contempt of parliament, and there punished with the utmost severity. It has likewise peculiar penalties annexed to it in the courts of law by the statutes 5 Henry IV. c. 6, and 11 Henry VI. c. 11. Nor can any member of either house be arrested and taken into custody without a breach of the privilege of parliament.

But all other privileges which derogate from the common law are now at an end, save only as to the freedom of the member's person; which in a peer, by the privilege of peerage, is for ever sacred and inviolable, and in a commoner, by the privilege of parliament, for forty days after every prorogation, and forty days before the next appointed meeting, which is now in effect as long as the parliament subsists, since it is seldom prorogued for more than eighty days at a time. As to all other privileges which obstruct the ordinary course of justice, they were restrained by the statutes 12 William III. c. 3, 2 and 3 Anne, c. 18, and 11 Geo. II. c. 24, and are now totally abolished by statute 10 Geo. III. c. 50, which enacts, that any suit may at any time be brought against any peer or member of parliament, their servants, or any other person entitled to privilege of parliament; and that it shall not be impeached or delayed by pretence of any such privilege, except that the person of a member of the House of Commons shall not thereby be subjected to any arrest or imprisonment. Likewise, for the benefit of commerce, it is provided by statute 4 Geo. III. c. 33, that any trader, having privilege of parliament, may be served with legal process for any just debt to the amount of L.100; and, unless he make satisfaction within two months, it shall be deemed an act of bankruptcy; and commissions of bankruptcy may be issued against such privileged traders, in like manner as against any other.

The only way by which courts of justice could anciently take cognizance of privilege of parliament was by writ of privilege, in the nature of a *supersedeas,* to deliver the party out of custody when arrested in a civil suit. For when a letter was written by the speaker to the judges to stay proceedings against a privileged person, they rejected it, as contrary to their oath of office. But since the statute 12 William III. c. 3, which enacts, that no privileged person shall be subject to arrest or imprisonment, it has been held that such arrest is irregular *ab initio,* and that the party may be discharged upon motion. It is to be observed, that there is no precedent of any such writ of privilege, but only in civil suits; and that the statute of 1 Jac. I. c. 13, and that of William III., which remedy some inconveniences arising from privilege of parliament, speak only of civil actions. Therefore the claim of privilege has usually been guarded with an exception as to the case of indictable crimes; or, as it has been frequently expressed, of treason, felony, and breach of the peace. Hence it seems to have been understood that no privilege was allowable to the members, their families, or servants, in any crime whatsoever; for all crimes are treated by the law as being *contra pacem domini regis*. Instances have not been wanting in which privileged persons have been convicted of misdemeanors, and committed, or prosecuted to outlawry, even in the middle of a session; proceedings which have afterwards received the sanction and approbation of parliament. To this it may he added, that the case of writing and publishing seditious libels was resolved by both houses not to be entitled to privilege; and the reasons upon which that case proceeded extended equally to every indictable offence. Thus the chief, if not the only privilege of parliament, in such cases, seems to be the right of receiving immediate information of the imprisonment or detention of any member, with the reason for which he is detained; a practice that is daily used upon the slightest military accusations, preparatory to a trial by a court martial, and which is recognised by the several temporary statutes for suspending the *habeas corpus* act, by which it is provided, that no member of either house shall be detained, till the matter of which he stands suspected be first communicated to the house of which he is a member, and the consent of the said house obtained for his commitment or detaining. But ever since the Revolution the usage has uniformly been to make the communication subsequently to the arrest.

4. For the despatch of business, each house of parliament has its speaker. The speaker of the House of Lords, whose office it is to preside there, and manage the formality of business, is the Lord Chancellor, or keeper of the king's great seal, or any other appointed by the king's commission; and if none be so appointed, the House of Lords may elect their own speaker. The speaker of the House of Commons is chosen by the house, but must be approved by the king. And herein the usage of the two houses differs. The speaker of the House of Commons cannot give his opinion or argue any question in the house; but the speaker of the House of Lords, if a lord of parliament, may do so. In each house the act of the majority binds the whole; and this majority is declared by votes openly and publicly given, not, as in Venice, and many other senatorial assemblies, privately or by ballot. The latter method may be serviceable, to prevent intrigues and unconstitutional combinations; but it is impossible to be practised with us, at least in the House of Commons, where every member's conduct is subject to the future censure of his constituents, and therefore should be openly submitted to their inspection.

5. It now only remains to add a word or two concerning the manner in which parliament may be adjourned, prorogued, or dissolved.

An adjournment is no more than a continuance of the session from one day to another, as the word itself signifies; and this is done by the authority of each house separately every day, and sometimes for a fortnight or a month together, as at Christmas or Easter, or upon other particular occasions. But the adjournment of one house is no adjournment of the other. It has also been usual, when his majesty has signified his pleasure, that both or either of the houses should adjourn themselves to a certain day, to obey the king's pleasure so signified, and to adjourn accordingly. Otherwise, besides the indecorum of a refusal, a prorogation would assuredly follow, and would often be very inconvenient both to public and to private business. For prorogation puts an end to the session; and then such bills as are only begun and not perfected must be resumed *de novo*, if at all, in a subsequent session; whereas, after an adjournment, all things continue in the same state as at the time of the adjournment, and may be proceeded in without any fresh commencement.

A prorogation is the continuance of the parliament from one session to another, as an adjournment is a continuation of the session from day to day. This is done by the royal authority, expressed either by the Lord Chancellor in his majesty's presence, or by commission from the crown, or frequently by proclamation. Both houses are necessarily prorogued at the same time, it not being a prorogation of the House of Lords or Commons, but of the parliament. The session is never understood to be at an end until a prorogation takes place; although, unless some act be passed, or some judgment given in parliament, it is in truth no session at all. Formerly the usage was, for the king to give the royal assent to all such bills as he approved, at the end of every session, and then to prorogue the parliament, though sometimes only for a day or two, after which all business then depending in the houses was to be begun again. This custom obtained so strongly, that it once became a question, whether giving the royal assent to a single bill did not of course put an end to the session. But though it was then resolved in the negative, yet the notion was so deeply rooted, that the statute 1 Car. I. c. 7, was passed to declare that the king's assent to that and some other acts should not put an end to the session; and even as late as the reign of Charles II. we find a proviso frequently tacked to a bill, that his majesty's assent thereto should not determine the session of parliament. But it seems to be allowed, that a prorogation must be expressly made, in order to determine the session; and if, at the time of an actual rebellion, or imminent danger of invasion, the parliament shall be separated by adjournment or prorogation, the king is empowered to call them together by proclamation, on fourteen days' notice of the time appointed for their re-assembling.

A dissolution is the civil death of the parliament; and this may be effected in three ways.

The first is, by the king's will, expressed either in person or by representation. For as the king has the sole right of convening the parliament, so also it is a branch of the royal prerogative, that he may, whenever he pleases, prorogue the parliament for a time, or put a final period to its existence. If no one had a right to prorogue or dissolve a parliament but itself, it might happen to become perpetual; and this would be extremely dangerous, if at any time it should attempt to encroach upon the executive power, as was fatally experienced by the unfortunate Charles I., who, having unadvisedly passed an act to continue the parliament then in being till such time as it should please to dissolve itself, at last fell a sacrifice to that inordinate power which he had himself consented to give them. It is therefore extremely necessary that the crown should be empowered to regulate the duration of these assemblies, under the limitations which the English constitution has prescribed; so that, on the one hand, they may frequently and regularly meet together for the despatch of business and redress of grievances, and, on the other, may not, even with the consent of the crown, be continued to an inconvenient or unconstitutional length.

Secondly, a parliament may be dissolved by the demise of the crown. This dissolution formerly happened immediately upon the death of the reigning sovereign; for he being considered in law as the head of the parliament (*caput, principium, et finis*), when that failed, the whole body was held to be extinct. But the calling a new parliament immediately on the inauguration of the successor being found inconvenient, and dangers being apprehended from having no parliament in being in case of a disputed succession, it was enacted by the statutes 7 and 8 William III. c. 15, and 6 Anne, c. 7, that the parliament in being should continue for six months after the death of any king or queen, unless sooner prorogued or dissolved by the successor; that if the parliament, at the time of the king's death, had been separated, by adjournment or prorogation, it should notwithstanding assemble immediately; and that if no parliament was then in being, the members of the last parliament should assemble and be again a parliament.

Lastly, a parliament may be dissolved or expire by mere length of time. If the legislative body were perpetual, or if it lasted during the life of the prince who convened it, as formerly, and were to be supplied, by occasionally filling up the vacancies with new representatives; in these cases, were it once corrupted, the evil would be past all remedy: but when different bodies succeed each other, if the people see cause to disapprove of the present, they may rectify its faults in the next. A legislative assembly, also, which is sure to be separated, and its members to become private men, subject to the full operation of the laws which they have enacted for others, will think themselves bound in interest as well as in duty to make only such laws as are good. The utmost extent of time that the same parliament was allowed to sit, by the statute 6 William and Mary c. 3, was three years; after the expiration of which, reckoning from the return of the first summons, the parliament was to have no longer continuance. But by the 1st of Geo. I. stat. ii. c. 38, professedly enacted to prevent the great and continued expenses of frequent elections, and the violent heats and animosities consequent thereupon, and for the peace and security of the government, then just recovering from the effects of a rebellion, this term was prolonged to seven years; and, what alone is an instance of the vast authority of parliament, the very same house which was chosen for three years, enacted its own continuance for seven. As the constitution now stands, therefore, the parliament must expire, or die a natural death, at the end of every seventh year, if not sooner dissolved by the royal prerogative.

We shall conclude this article with an account of some general forms not noticed under any of the preceding heads.

In the House of Lords, the princes of the blood sit by themselves on the sides of the throne; and at the wall, upon the king's right hand, the two archbishops sit by themselves on a form. Below them, the bishops of London, Durham, and Winchester, and all the other bishops sit according to the priority of their consecration. On the king's left hand the Lord Treasurer, Lord President, and Lord Privy Seal, sit upon forms above all dukes, except those of the royal blood; then the dukes, marquises, and earls according to their creation. Across the room are wool sacks, continued from an ancient custom; and the Chancellor or Keeper, being of course the speaker of the House of Lords, sits on the first wool sack before the throne, with the great seal or mace lying by him; and below these there are forms for the viscounts and barons. On the other wool sacks are seated the judges, masters in chancery, and king's counsel, who are only to give their advice in points of law; but they all stand up till the king gives them leave to sit.

The Commons sit promiscuously, only the speaker has a chair at the upper end of the house, and the clerk and his assistant sit at a table near him. When a member of the House of Commons speaks, he stands up uncovered, and directs his address to the speaker only. If what he says be answered by another, he is not allowed to reply the same day, unless personal reflections have been cast upon him; but when the Commons, in order to have greater freedom of debate, have resolved themselves into a committee of the whole house, every member may speak to a question as often as he thinks necessary. In the House of Lords they vote, beginning at the puisne or lowest baron, and so up orderly to the highest, every one answering *content* or *not content*. In the House of Commons they vote by *yeas* and *nays*; and if it be dubious which are the greater number, the house divides. If the question be about bringing any thing into the house, the *yeas* go out, but if it be about any thing the house already has, the *nays* go out. In all divisions the speaker appoints four tellers, two of each opinion. In a committee of the whole house, they divide by changing sides, the *yeas* taking the right and the *nays* the left of the chair; and then there are but two tellers. If a bill pass one house, and the other demur to it, a conference is demanded in the painted chamber, where certain members are deputed from each house; and here the Lords sit covered, whilst the Commons stand bare, and debate the case. If they disagree, the affair is null; but if they agree, this, with the other bills which have passed both houses, is brought down to the king in the House of Lords, who comes thither clothed in his royal robes. Before him the clerk of the parliament reads the title of each bill, and as he reads, the clerk of the crown pronounces the royal assent or dissent. If it be a public bill, the royal assent is given in these words, *Le roy le veut,* The king will have it so; if a private bill, *Soit fait comme il est desiré,* Let the request be complied with: but if the king refuse the bill, the answer is, *Le roy s'avisera,* The king will think of it; and if it be a money bill, the answer is, *Le roy remercie ses loyaux sujets, accepte leur benevolence, et aussi le veut,* The king thanks his loyal subjects, accepts their benevolence, and therefore grants his consent.

High Court of PARLIAMENT is the supreme court in the kingdom, not only for the making, but also for the execution of laws, by the trial of great and enormous offenders, whether Lords or Commoners, in the method of parliamentary impeachment. As for acts of parliament to attaint particular persons of treason or felony, or to inflict pains and penalties, beyond or contrary to the common law, in order to serve a special purpose, we speak not of them; they are to all intents and purposes new laws, made *pro re nata,* and by no means an execution of such as are already in being. But an impeachment before the Lords by the Commons of Great Britain in parliament, is a prosecution of the already known and established law, and has been frequently put in practice; being a presentment to the highest or supreme court of criminal jurisdiction by the most solemn grand inquest of the whole kingdom. A commoner cannot, however, be impeached before the Lords for any capital offence, but only for high misdemeanors; but a peer may be impeached for any crime. In the case of an impeachment of a peer for treason, the Lords usually address the crown to appoint a lord high steward, for the greater dignity and regularity of their proceedings; and this high steward was formerly elected by the peers themselves, though he was generally commissioned by the king; but it has latterly been strenuously maintained, that the appointment of a high steward in such cases is not indispensably necessary, and that the house may proceed without one. The articles of impeachment are a kind of bills of indictment, found by the House of Commons, and afterwards tried by the Lords, who in cases of misdemeanors are considered not only as their own peers, but likewise as the peers of the whole nation. This is a custom derived from the constitution of the ancient Germans, who, in their great councils, sometimes tried capital accusations relating to the public: *Licet apud concilium accusare quoque, et discrimen capitis intendere.* And it has a peculiar propriety in the English constitution, which has much improved upon the ancient model imported hither from the Continent. For although the union of the legislative and judicial powers ought in general to be most carefully avoided, yet it may happen that a subject, intrusted with the administration of public affairs, may infringe the rights of the people, and be guilty of such crimes as the ordinary magistrate either dares not or cannot punish. Of these the representatives of the people, or the House of Commons, cannot properly judge, because their constituents are the parties injured, and can therefore only impeach. But before what court shall this impeachment be tried? Not before the ordinary tribunals, which would naturally be swayed by the authority of so powerful an accuser. Reason therefore suggests that this branch of the legislature, which represents the people, must bring its charge before the other branch, which consists of the nobility, who have neither the same interests, nor the same passions, as popular assemblies. The constitution of our island enjoys this vast superiority over those of the Grecian and Roman republics, where the people were at the same time judges and accusers, and where the accused were continually liable to become the victims of popular prejudice, passion, and resentment. It is therefore proper that the nobility should judge, to insure justice to the accused, as it is proper that the people should accuse, to insure justice to the commonwealth. Amongst other extraordinary circumstances attending the authority of this court, there is one of a very singular nature, which was insisted on by the House of Commons in the case of the Earl of Danby in the reign of Charles I., and is now enacted by statute 12 and 13 William III. c. 2, that no pardon under the great seal shall be pleadable to an impeachment by the Commons of Great Britain in parliament.

For a more general view of the British Constitution, the reader is referred to the article ENGLAND.

PARMA, a sovereign state, called a duchy, in Italy. It consists of three districts, viz. Parma, Piacenza, and Borgo St Domino, which, under the government of Napoleon, formed the department of the Taro, to which has been added the small duchy of Guastalla, now a fourth division. It is situated between Modena, the Austrian territory of Mantua, and the river Po, extends over 2266 square miles, and contains about 420,000 inhabitants, all of whom adhere to the Roman Catholic church. The district is generally a level plain, and part of it belongs to that of Lombardy. A portion of the Apennines is within the duchy, but it includes none of the higher elevations of that range of mountains. The Po, which is the northern boundary, receives the waters of the numerous small streams which, rising in the Apennines, serve the purpose of irrigation, and give fertility to the soil. The land is generally farmed on the metayer system, and the succession of crops is generally as follows: In the first year a fallow, with tobacco, maize, or hemp, well manured; in the second year rye; in the third beans; in the fourth wheat, manured; in the fifth clover; and in the sixth corn of some kind. More grain is produced than suffices for consumption, and abundance of flax, tobacco, and maize is exported, as well as fruit, wine, and olive oil. Silk is also produced in great abundance. The greatest profit of the husbandry of Parma is derived from the cattle. The cows are numerous, and of an excellent race; and the cheese as well as the butter produced yield large gains. The sheep are numerous, their flesh is good, and many of them yield the finest wool. There are mines of copper and of iron worked; and the several articles composed of these metals are manufactured within the duchy. Marble and alabaster are drawn from the quarries. Abundance of mineral oil is furnished from springs, and is used not only for greasing wheels of carriages, but for lighting the streets. There are few manufactures, and those which do exist are upon a small scale, and for domestic use. The government is monarchical, and is at present vested in Maria Louisa, the wife of Napoleon, but after her demise it will descend to the Duchess of Lucca. The revenues of the duchy amount to L.187,000. The military force consists of 3600 men, but only one third of them is in service at the same time.

PARMA, the capital of the duchy of that name, is a city situated on the river Parma, which divides it into two parts, and stands about three hundred feet above the level of the sea. It is surrounded with walls and ditches, protected by bastions, and it has also a citadel; but the fortifications are scarcely tenable against a serious attack. It is well built, and has broad, well-paved streets, with large palaces and houses; but few of them display much architectural taste, and even the ducal residence is not elegantly constructed. The opera-house is distinguished by its size; and some of the churches are large and magnificent. There is a university of ancient celebrity, an episcopal seminary, and a college for nobility. The inhabitants depend on their estates or on the court, and amount to 28,750 persons. Long. 10. 15. 14. E. Lat. 44. 48. 1. N.

PARMIGIANO, a celebrated painter, whose true name was Francesco Mazzuoli; but he received that of Parmigiano from the city of Parma, where he was born in 1504. He was brought up under his two uncles, and was an eminent painter when but sixteen years of age. He was famous all over Italy at nineteen; and at twenty-three he performed such wonders, that when the general of the Emperor Charles V. took Rome by storm, some of the common soldiers, having broken into his apartments, found him intent upon his work, and were so struck with the beauty of his pieces, that instead of involving him in the plunder and destruction in which they were then employed, they resolved to protect him from all manner of violence. His works are distinguished by the beauty of the colouring, the invention, and the drawing. His figures are spirited and graceful, particularly in respect to the choice of attitude, and the arrangement of drapery. He also excelled in music, in which he much delighted.

In large compositions Parmigiano did not always reach a high degree of excellence; but in his holy families, and other similar subjects, the gracefulness of his heads, and the elegance of his attitudes, are peculiarly remarkable. For the celebrity of his name he appears to have been chiefly indebted to his numerous drawings and etchings. As his life was short, and a great part of it consumed in the idle study of alchemy, and in the seducing avocations of music and gambling, but little time remained for application to the laborious part of his business. His paintings in oil are few in number, and held in high esteem; as are likewise his drawings and etchings. Good impressions of the last, however, are very rarely to be found. He was the first who practised the art of etching in Italy; and probably he did not at first know that it had been for some years practised in Germany. His principal works are at Parma, where he died poor in 1540.

PARNASSUS, a mountain of Phocis, near Delphi, with two tops; the one sacred to Apollo, the other sacred to Bacchus. It is thus described by Chandler:—"Parnassus was the western boundary of Phocis, and, stretching northward from about Delphi toward the Œtæan Mountains, separated the western Locri from those who possessed the sea-coast before Eubœa. It was a place of refuge to the Delphians in times of danger. In the deluge which happened under Deucalion, the natives were saved on it by following the cry of wolves. On the invasion by Xerxes, some transported their families over to Achaia, but many concealed them in the mountain, and in Corycium, a grotto of the Nymphs. All Parnassus was renowned for sanctity, but Corycium was the most noted among the hallowed caves and places. 'On the way to the summit of Parnassus,' says Pausanias, 'as much as sixty stadia beyond Delphi, is a brazen image; and from thence the ascent to Corycium is easier for a man on foot, and for mules and horses. Of all the caves in which I have been, this appeared to me the best worth seeing. On the coasts, and by the sea side, are more than can be numbered; but some are very famous both in Greece and in other countries. The Corycian cave exceeds in magnitude those I have mentioned, and for the most part may be passed through without a light. It is sufficiently high; and has water, some springing up, and yet more from the roof, which petrifies, so that the bottom of the whole cave is covered with sparry icicles. The inhabitants of Parnassus esteem it sacred to the Corycian nymphs, and particularly to Pan. From the cave to reach the summits of the mountain is difficult even to a man on foot. The summits are above the clouds, and the women called *Thyades* madden on them in the rites of Bacchus and Apollo.' Their frantic orgies were performed yearly. Wheler and his company ascended Parnassus from Delphi, some on horses, by a track between the stadium and the clefts of the mountain. Stairs were cut in the rock, with a strait channel, perhaps a water-duct. In a long hour, after many traverses, they gained the top, and entering a plain, turned to the right, towards the summits of Castalia, which are divided by deep precipices. From this eminence they had a fine prospect of the Gulf of Corinth, and of the coast; Mount Cirphis appearing beneath them as a plain, bounded on the east by the bay of Asprospitia, and on the west by that of Salona. A few shepherds had huts there. They returned to the way which they had quitted, and crossed a hill covered with pines and snow. On their left was a lake, and beyond it a peak, exceedingly high, white with snow. They travelled to the foot of it through a valley four or five miles in compass, and rested by a plentiful fountain called *Drosonigo*, the stream boiling up a foot in diameter, and nearly as much above the surface of the ground. It runs into the lake, which is about a quarter of a mile distant to the south-east. They did not discover Corycium, or proceed farther on, but keeping the lake on their right, came again to the brink of the mountain, and descended by a deep and dangerous track to Racovi, a village four or five miles eastward from Delphi. It was the opinion of Wheler, that no mountain in Greece was higher than Parnassus; that it was not inferior to Mont Cenis amongst the Alps; and that, if detached, it would be seen at a greater distance than even Mount Athos. The summits are perpetually increasing, every new fall of snow adding to the perennial heap, whilst the sun has power only to thaw the superficies. Castalis, Pleistus, and innumerable springs are fed, some invisibly, from the lakes and reservoirs, which, without these drains and subterraneous vents, would swell, especially after heavy rains and the melting of snow, so as to fill the valleys, and run over the tops of the rocks down upon Delphi, spreading wide an inundation, similar, as has been surmised, to the Deucalionian deluge."

PARNELL, Dr Thomas, an ingenious divine and an elegant poet. He was archdeacon of Clogher, and the intimate friend of Pope, who published his works, with a copy of recommendatory verses prefixed. He died in 1718, at the age of thirty-nine. "The life of Dr Parnell," says Johnson, "is a task which I should very willingly decline, since it has been lately written by Goldsmith, a man of such variety of powers, and such facility of performance, that he always seemed to do best that which he was doing; a man who had the art of being minute without tediousness, and general without confusion; whose language was copious without exuberance, exact without constraint, and easy without weakness. What such an author has told, who would tell again? I have made an extract from his larger narrative; and shall have this gratification from my attempt, that it gives me an opportunity of paying due tribute to the memory of a departed genius.

Το γαρ γερας ἐστι θανοντων.

"The general character of Parnell is not great extent of comprehension, or fertility of mind. Of the little that appears, still less is his own. His praise must be derived from the easy sweetness of his diction. In his verses there is more happiness than pains; he is sprightly without effort, and always delights though he never ravishes; everything is proper, yet everything seems casual. If there is some appearance of elaboration in the Hermit, the narrative, as it is less airy, is less pleasing. Of his other compositions, it is impossible to say whether they are the productions of nature so excellent as not to want the help of art, or of art so refined as to resemble nature."

PARNELLA, a town and district of Hindustan, in the province of Bejapoor, and one of the most healthy in the Mahratta dominions. Long. 74. 15. E. Lat. 16. 50. N. It was at this place that Aurungzebe's camp was stationed in April 1701, when Sir W. Norris, the ambassador from the English East India Company, arrived to treat with him.

PARO, more properly Beni, a great river of South America, and one of the three principal streams which form the famous Madera. Of these, the Paro is the first or most western branch. It is formed of an infinite number of smaller streams, which, falling into it within a short distance of each other, soon constitute a very considerable body of water. They have their sources in the mountains of Pelechuco, Suches, Sorata, Challana, Songa, La Paz, Suri, and Cochabamba, which ranges form part of the snowy cordillera visible from the city of La Paz. The farthest to the west is the Tuche; then follow the Aten, the Mapiri or Sorata, and the rivers which, descending from the celebrated mines of Tipuani, from Challana and from Coroico, afterwards unite; then the Chulumani and its tributary streams, the Taniampaya, the Solacama, the Rio de la Paz, the Suri, and the Canamena; and, last of all, there is the Cotacajes. Owing to the rapidity with which these currents descend from the cordillera, their navigation is difficult and dangerous; but the Indians display such dexterity in the management of their balsas or rafts, that the traveller has nothing to fear. Below Reyes, in about 12½° of south latitude, the Paro receives various other streams from the west, as the Tequeje, the Masisi or Cavinas, and others. From its junction with the Marmore, in about 10° south latitude, both rivers lose their names in that of the Madera. The course of the Paro lies between 10° and 17° 30′ of south latitude. It waters the whole of the district of Mosetenes, skirts the province of Moxos, and pursues its north-easterly course to the Marmore, through a fine level country. It would be extremely easy to unite the Beni with the Marmore, by means of the river Yacuma, which rises near Reyes, situated on the eastern bank of the Beni, and running eastward through the flat country between them, falls into the Marmore close to the town of Santa Anna. The fall of the land is so imperceptible, and so nearly on a level with the horizon, that it does not exceed twenty feet in a distance of more than sixty leagues. In the range of country traversed by the Paro, there is every variety of hill and dale, and plains with abundant smaller streams of running water. The vast and extensive levels along the banks offer the finest situations for agricultural establishments, and for the maintenance of a numerous population. The great fertility of the country is evinced by the extraordinary growth of the trees, and the innumerable plants which are spontaneously produced, affording sustenance and shelter to a prodigious variety of the animal creation. The best lands are principally occupied by the Mosetenes Indians, who give their name to the country where they chiefly reside. About Reyes are the Maropas tribe of Indians; lower down are the Pacaquaras, and there are a number of others which do not require to be particularly mentioned. (R. R. R.)

PARODY, a poetical pleasantry, consisting in applying the verses written on one subject, by way of ridicule, to another; or in turning a serious work into burlesque, by affecting to observe, as nearly as possible, the same rhymes, words, and cadences, in treating a mean, low, or ridiculous one.

The parody was first introduced by the Greeks, from whom the name has been borrowed. It comes pretty near to what some of the modern writers call *travesty*. Others, however, have more accurately distinguished between a parody and burlesque, observing, that the change of a single word may parody a verse, or that of a single letter a word. Thus, in the case of a word, Cato exposed the inconstant disposition of Marcus Fulvius Nobilior, by changing Nobilior into Mobilior. Another kind of parody consists in the mere application of some known verse, or portion of a verse, in a writer, without making any change in it, with a view to expose it. A fourth instance is that of writing verses in the taste and style of authors little approved. The rules of parody regard the choice of a subject, and the manner of treating it. The subject should be a known and celebrated work; and as to the manner, it should be an exact imitation, with an intermixture of good-natured pleasantry.

PAROLE, in a military sense, the promise made by a prisoner of war, when he has leave to go anywhere, of returning at a time appointed, if not exchanged.

PAROLE means also a word given out every day in orders by the commanding officer, both in camp and in garrison, for the purpose of distinguishing friends from enemies.

PARONOMASIA, in *Rhetoric*, a pun, or a figure, by which words nearly alike in sound, but of very different meanings, are affectedly or designedly used.

PAROS, an island belonging to the Turkish empire, in the Ægean Sea. It is separated by a narrow channel from Noxia on the eastern, and from Antiparos on the western side. It extends over 104 square miles, and contains about 2000 inhabitants. It is naturally fertile, but, by the conduct of the government, the population, mostly Greeks, are very much impoverished; and there is also a scarcity of water. The chief town is Parichia, situated on the western coast, with a good haven, and about 700 inhabitants. It was once celebrated for its marbles. Long. 19. 15. E. Lat. 42. 45. N.

PARPARSARAT, an island in the Eastern Seas, near the coast of Sumatra, and in the Straits of Malacca. It is fifty miles in circumference. Long. 102. 15. E. Lat. 1. 21. N.

PARR, CATHARINE, queen of England, was the eldest daughter of Sir Thomas Parr of Kendal. She was first married to John Nevil, Lord Latimer, and after his death was, by her marriage with Henry VIII., raised to the throne. The royal nuptials were solemnized at Hampton Court on the 12th of July 1543. This lady, being religiously disposed, was, in the early part of her life, a zealous observer of the rites and ceremonies of the Catholic Church; but on the dawning of the Reformation, she became as zealous a promoter of the Lutheran doctrine, though with all the prudence and circumspection which her perilous situation required. Nevertheless, it is alleged that she was in great danger of falling a sacrifice to the popish faction, the chief of which was Bishop Gardiner, who is said to have drawn up articles against her, and prevailed on the king to sign a warrant to remove her to the Tower. This warrant, however, was accidentally dropped, and immediately conveyed to her majesty. What her apprehensions must have been on making such a discovery may be easily imagined. Knowing the character of the monarch, and recollecting the fate of his former queens, she was seized with a sudden illness. The news of her indisposition brought the king to her apartment. He was lavish in expressions of affection, and sent her a physician. His majesty also being soon afterwards indisposed, she prudently returned the visit. With this the king seemed pleased, and began to talk with her on religious subjects, proposing certain questions, concerning which he wanted her opinion. She answered, that such profound speculations were not suited to her sex; that it belonged to the husband to choose principles for his wife; that the wife's duty was, in all cases, to adopt implicitly the sentiments of her husband; and that as to herself, it was doubly her duty, being blessed with a husband who was qualified, by his judgment and learning, not only to choose principles for his own family, but for the most wise and knowing of every nation. "Not so, by St Mary," replied the king; "you are now become a doctor, Kate, and better fitted to give than receive instruction." She meekly replied, that she was sensible how little she was entitled to these praises; that although she usually declined not any conversation, however sublime, when proposed by his majesty, she well knew that her conceptions could not serve any other purpose than to give him a little momentary amusement; that she found the conversation a little apt to languish when not revived by some opposition, and she had ventured sometimes to feign a contrariety of sentiments, in order to give him the pleasure of refuting her; and that she also proposed, by this innocent artifice, to engage him into topics, whence she had observed, by frequent experience, that she reaped profit and instruction. "And is it so, sweetheart?" replied the king; "then we are perfect friends again." He embraced her with great affection, and sent her away with assurances of his protection and kindness.

The time being now come when she was to be sent to the Tower, the king, walking in the garden, sent for the queen, and met her with great good humour; when the chancellor, with forty of the guards, approached. He fell upon his knees, and spoke softly with the king, who called him knave, arrant knave, beast, fool, and commanded him instantly to depart. Henry then returned to the queen, who ventured to intercede for the chancellor: "Ah, poor soul," said the king, "thou little knowest how ill he deserveth this grace at thy hands. Of my word, sweetheart, he has been toward thee an arrant knave; and so let him go." The king died in January 1547, just three years and a half after his marriage with this second Catharine, who, in a short time, was again espoused to Sir Thomas Seymour, lord-admiral of England; and in September 1548 she died in childbed. The historians of this period generally insinuate that she was poisoned by her husband, to make way for his marriage with the lady Elizabeth.

Catharine Parr wrote, 1. Queen Catharine Parr's Lamentation of a Sinner, bewailing the ignorance of her blind life, London, 1548, 1563, in 8vo; 2. Prayers or Meditations, wherein the mind is stirred patiently to suffer all afflictions here, to set at nought the vain prosperity of this world, and always to long for the everlasting felicity, printed by John Wayland, 1545, 4to, reprinted 1561, 12mo.

PARR, SAMUEL, a critic, metaphysician, theologian, and one of the most learned classical scholars of the age in which he lived, was born at Harrow-on-the-Hill, on the 15th of January 1747, O. S. His father, an apothecary and surgeon at Harrow, was equally distinguished by vigorous intellect, a spirit of manly independence, and great professional skill.

At Easter 1752, young Parr was admitted on the foundation of Harrow School, at that time conducted by the Rev. Dr Thackeray, and, for a long series of years, one of the most celebrated and successful of those great classical seminaries the pupils of which have contributed so largely to shed unparalleled lustre on the English name. That schools and universities can but initiate their pupils in the principles of literature and science, and ought not, perhaps, to aim at more, it would be unwise to dispute.

That those pre-eminent geniuses who have, in all ages of the world, enlarged the field of science by their discoveries, or embellished literature by their taste, have owed their success and reputation to their native talents and persevering industry, may without scruple be admitted as established facts in the history of the human mind. Still, it is a truth no less capable of demonstration, that in most instances the *primary* causes of great eminence and high attainment in the pursuits of life may be traced to the impulse given by the teacher's well-directed precepts, and the mutual collision of kindred minds in the strife of early competition. It may fairly be assumed, that, to the rare combination of these circumstances operating on a mind essentially powerful and capacious, Parr was in no ordinary degree indebted for his extensive scholarship and well-earned fame. When we find that Thackeray and Sumner were his instructors, and that such men as Sir William Jones, and Dr Bennet, bishop of Cloyne, were his schoolfellows and inseparable companions, we are naturally and easily prepared to anticipate, even in this early period of his intellectual career, an energetic development of those powers of thought which, in the progress of life, unfolded themselves with almost unexampled force and vigour. At the early age of fourteen, he had by his diligence and talents gained the approbation of his successive teachers; and, in January 1761, he became the head boy of the school. The elevated rank which he thus held amongst his school-fellows clearly indicates how thoroughly and effectively he devoted himself to those classical studies in which, to the latest years of his life, he felt such intense delight. But to these, even at this period of his life, his time and attention were not exclusively confined. Before he had completed his course of scholastic training at Harrow, though metaphysics and dialectics offer but few attractions to the mind of boyhood, he had made no inconsiderable proficiency in these branches of mental science, and had maintained upon subjects connected with them many a friendly conflict with the generous rivals of his honours and partners of his studies. These prolusions of juvenile genius and talent were not a useless display of intellectual gladiatorship, or unaccompanied with improvement to the youthful combatants. The faculties of the mind, like the powers of the body, are invigorated by frequent exercise, and only attain their full development in point of energy and capacity by the excitement of generous and salutary competition.

In 1761, Parr, having completed the course of study pursued at Harrow, left school, and was, for two or three subsequent years, employed by his father in his own profession. But though the duties in which he was thus necessarily engaged occupied much of his time, and were calculated in some degree to withdraw his attention from the studies of earlier years, his classical pursuits were never entirely suspended, nor did his ardent devotion to Greek and Roman literature experience any abatement or change. It was not to be expected that one whose taste was so exquisitely alive to the beauties of the classic page, would apply with equal warmth of interest to the compounding of medicines, and the other duties of the laboratory, or regard as any thing else than an irksome task the manipulations of a profession which was so little congenial to his aspirations and desires.

Determined by such unequivocal proofs of his decided predilection for literary pursuits and academical studies, his father, after considerable hesitation, resolved at last to accommodate his views to the wishes of his son, and in 1765 entered him at Emanuel College, Cambridge. In this noble arena of mental activity, where all was in harmony with his most eager wishes, his application to study was enthusiastic, incessant, and severe. Classical reading, mathematics, and those subsidiary but indispensable investigations by which a thorough knowledge of these subjects is acquired and established, were pursued, not merely for their own sake, but as opening up to their successful cultivator the sure path to academical honours and distinction. These exciting and pleasing prospects, however, were not destined to be realized. The inadequacy of the means necessary for his longer continuance at Cambridge, in consequence of his father's death, induced him gratefully to accept the proposal made to him by Dr Sumner, to take the vacant place of first assistant in Harrow School.

At Christmas 1769 he was ordained to the curacies of Willsden and Kingsbury, in Middlesex, the duties of which, in conjunction with those proper to the situation which he held in the school, he continued to discharge till the death of Dr Sumner in 1771. In Dr Sumner he found a faithful friend and counsellor, and gave such satisfaction to the pupils and their parents, that, on the occurrence of this vacancy of the head-mastership of Harrow School, he felt himself called upon to become a candidate, and was on every ground justified in making such an application. He was unsuccessful; the election fell on Dr Heath, an assistant at Eton, whose merit and success amply justified the choice of the governors. He so far resented this decision in favour of the successful candidate, as to resign his assistantship, and open a school at Stanmore, to which he was, from affectionate attachment, followed by forty of the pupils whom he had taught at Harrow.

The success of this undertaking, however, corresponded but ill with the auspicious beginning that ushered it in; and a variety of circumstances concurred, of such a nature as to recommend the propriety of a change of situation, and to render it desirable. Influenced, accordingly, by these considerations, he became a candidate for the school of Colchester, and having succeeded in attaining the appointment, he went to reside there in 1777. During his residence at Colchester he took priest's orders, and his curacies were Hythe and Trinity Church.

In 1778, he obtained the appointment of head-master of Norwich School, and early in 1779 entered upon the duties of his office. In the following year he published his two sermons, "On the Truth and Usefulness of Christianity," and "On the Education of the Poor." He afterwards, in 1785, resumed the subject of the latter at greater length, in his "Discourse on Education, and on the Plans pursued in Charity Schools." This was the most popular of all his writings, and is a conspicuous and noble monument of its gifted author's enlarged views, pure benevolence, and deep insight into human character. The general education of the people in any nation, and still more the extension of its advantages and blessings to the whole human race, are subjects on which the genuine philanthropist and truly enlightened Christian dwell with delight and rapture. And in what, indeed, can the friend of his fellow-men more worthily employ his time and talents, than in promoting those comprehensive schemes which aim, not at the elevation of one class of men above another in worldly dignity and grandeur, nor at the temporary glory and exaltation of any single nation or race of men, but at raising higher in the scale of intelligence and happiness all of every tribe on whom the Common Parent has bestowed the capacity of mental, moral, and religious culture? This has since become in Great Britain a national and engrossing topic; theory and practice have mutually and equally contributed their aid to the advancement of national and universal education; and he who, half a century before his death, advocated with such ability and power the cause of the poor and ignorant, had the felicity to witness the dawn of that brighter era in the history of mankind, the meridian effulgence of which must precede or accompany the universal diffusion of pure religion and divine truth. These elaborate and masterly discourses, elucidating, as they do, a subject of permanent and incalculable interest, will always be perused with admiration and benefit. They will extend the reader's information, and improve his heart. They are pervaded and beautified by a deep tone of fervent piety, and breathe the warmest wishes for the intellectual, moral, and spiritual interests of the great family of man.

In 1781, Parr took his degree of doctor of laws in the University of Cambridge, after supporting two theses, which were regarded as compositions of superior excellence and merit. In 1783, he was by Dr Robert Lowth, bishop of London, appointed one of the prebends of St Paul's cathedral. The duties of this office were nearly nominal, but its revenues afforded him the means of comfort and independence during the remainder of his life. In 1783, he was presented by Lady Jane Trafford to the perpetual curacy of Hatton, Warwickshire, to which, after resigning the school at Norwich, he went to reside in 1786. Here he continued to devote his leisure to the tuition of a limited number of pupils; and, by making it his permanent residence to the end of his life, he bequeathed to it that celebrity and interest which any locality, however obscure, necessarily and justly derives from the fame of an illustrious inhabitant.

In 1787 appeared the justly celebrated preface to Bellendenus, of which Henry Homer, fellow of Emanuel College, Cambridge, was editor. Bellenden, the author, was a learned Scotchman, master of requests to James I., and professor of humanity at Paris in the beginning of the seventeenth century. The three books of Bellendenus are in this edition dedicated to Mr Burke, Lord North, and Mr Fox. The preface by Dr Parr, which is prefixed to the original work of Bellenden, delineates, in elegant and vigorous language, the characters of the three distinguished statesmen to whom the respective books are dedicated. This singularly felicitous composition, though too slavishly and undisguisedly a *cento*, is undeniably one of the most successful modern imitations of Ciceronian Latin. But the highly embellished eloquence and precise discrimination of character, which give such value to this masterly declamation, can never be accepted as a compensation or atonement for the rude sarcasm, the contemptuous and unmeasured virulence, with which he assails, unprovoked, the devoted objects of his political vengeance. This extraordinary production was read with avidity, and created a very uncommon sensation amongst the men of letters and politicians of the day. It was productive, however, of no effects beneficial to the author; and alienated from him, in all probability, the minds of many who would otherwise have proved friendly or indifferent. Even the statesmen whom he had so lavishly and eloquently panegyrised, when they reached the summit of power, and became dispensers of ecclesiastical honours and emoluments, granted him no promotion; and his warmest friends have seriously deplored the employment of his talents in a manner so inconsistent with his sacred character. It is a matter of deep regret that he should have so far extinguished in his breast the meek and gentle spirit of that religion, the peaceful and holy duties of which he was bound, equally by precept and example, to impress on the hearts and consciences of men.

The generosity of his nature, and his readiness to oblige, by giving a real or supposed friend the benefit of his great talents, brought him oftener than once into unhappy collision with inferior men, who scrupled not to arrogate importance to themselves, by laying claim to compositions in the merits and excellence of which they were in reality entitled to but a secondary and subordinate share. In 1790, we find him involved in an obscure and intricate controversy of this kind respecting the authorship of the Bampton Lectures, published by Dr White. It would be an uninstructive and fruitless deviation from the conciseness necessary to be observed in this biographical outline, to enter fully into the merits of this dark transaction; but the letters published by Dr Johnson, in his memoirs of Parr's life and writings, have clearly established the fact, that much of the talent displayed in these admirable compositions, if not the conception of the whole work, must in justice be ascribed to the transcendent energy of Parr's capacious mind. On the contrary, White, Badcock, and the other individuals who make a figure in this discreditable controversy, stand convicted, upon satisfactory evidence, of mean and ungrateful plagiarism.

The "Tracts by Warburton and a Warburtonian, not admitted into the collection of their respective works," appeared in 1789, with a dedication addressed by the editor to a learned critic, containing some excellent critical remarks, and abounding at the same time in forcible expression and happy illustration. Of this composition Warton, no mean authority, is reported to have said, that if he were called upon to point out some of the finest sentences in English prose, he would quote Parr's Preface and Dedication of the Warburtonian Tracts.

The tremendous explosion in France, of that revolutionary volcano which seemed to threaten the world with a total dislocation of civilized society, made the shock be felt in every region of the earth. The immediate vicinity of Britain to the scene of this great convulsion, exposed her population in a peculiar degree to the danger of being involved in all the terrific consequences of a similar catastrophe. The inhabitants of this island had long claimed and enjoyed, as their inalienable birthright, the most unlimited freedom of thought, speculation, expression, and action. In a country so situated and so circumstanced, therefore, it was not to be conceived or expected that the movements of so vast a revolution would not receive from some the most sympathising admiration, whilst by others they would be contemplated with horror and repugnance. And whilst every member of the great British commonwealth discussed, with all the confidence of the most profound and enlightened statesman, such subjects as policy, government, the rights, natural or acquired, of individuals and communities, and all else that concerns the great destinies of man as a member of social life, it was not to be expected that Dr Parr alone would remain apathetic and unmoved amidst the heats and conflicts of political controversy by which he was surrounded. But although every action of his long life proves him to have been the steady and consistent advocate of freedom, he was too well acquainted with the history of democracy in all its modifications, and in every age, to favour its pretensions, or lend the aid of his great talents to the support of its excesses and extravagance. Parr was no Jacobin. He was a decided, sincere, unflinching Whig, and in principle a firm supporter of the constitutional liberties of Britain. He was not, however, of a temper to disguise his opinions on any subject in which he felt and took an interest; and accordingly he sometimes expressed himself with such boldness and freedom on questions of civil policy, that he incurred the imputation of regarding with favour and partiality the doctrines promulgated and acted upon by the republican revolutionists of France. As the alleged abettor of such principles, he was about this period of his life exposed to assaults, on the assumed ground that he was guilty of political delinquencies, which his life disproves and his writings disavow.

Parr shunned neither churchman nor dissenter who was unblemished in character and eminent in talents. With Dr Priestley, amongst others, he had exchanged civilities; and when the library and philosophical apparatus of the latter were in 1791 consigned to destruction by the Birmingham rioters, the knowledge that such intercourse had subsisted between them prompted the infuriated mob to regard both as holding and professing the same common principles and sentiments. Under the influence of this dangerous delusion, they threatened to commit Dr Parr's house and library also to the flames, and manifested so decided a determination to carry their threats into execution, that it was judged a necessary precaution to remove the books to a place of safety. Before, however, the incendiaries were able to put their design in execution, their proceedings were checked by the seasonable interposition of the military. Of these riots a durable record is preserved in the "Sequel to the printed Paper lately circulated in Warwickshire, by the Rev. Charles Curtis, brother of Alderman Curtis, a Birmingham Rector, London, 1792;" of which the preface is justly admired as one of the most perfect specimens of the author's composition in his best and most laboured style. A prevalent rumour that the dissenters in the following year meditated a meeting in commemoration of the French Revolution, similar to that which had led to and provoked the riots of the preceding year, occasioned the hasty composition and publication of "A Letter from Irenopolis to the Inhabitants of Eleutheropolis; or, a Serious Address to the Dissenters of Birmingham;" a tract which, in elegance, perspicuity, and vigour, may safely stand a comparison with the most finished and elaborate of his former writings. The dissenters immediately published a declaration, in which they disclaimed all intention of holding such a meeting as the reports currently circulated had given reason to expect.

In 1793, Parr, who it seems had with disinterested kindness afforded gratuitously considerable assistance to his friend Homer in preparing for the press the variorum edition of Horace in which he was engaged, was, upon the death of the original editor, hurried into a painful controversy with Dr Combe, who prosecuted the work to its completion. After Homer's death, Dr Parr, for some reason which has not been very clearly ascertained, not only withheld his countenance and assistance, but published a series of severe animadversions upon the work, in several numbers of the British Critic. Dr Combe published in reply a pamphlet, entitled "A Statement of the Facts relative to the Behaviour of the Rev. Dr Parr to the late Mr Homer and Dr Combe, in order to point out the source, falsehood, and malignity of Dr Parr's attack, in the British Critic, on the character of Dr Combe, 1794." The opprobrious and highly offensive terms emblazoned on the title-page of this tract were calculated to rouse the indignation of the meekest spirit, and could not with propriety and a sense of self-respect be allowed, unanswered, to infuse their venom into and corrupt the public mind. Dr Parr was neither insensible to the language of petulance and scorn, nor was his temper such as to submit tamely and in silence to outrage and abuse. He might indeed say with truth,—

> Qui me commôrit (melius non tangere, clamo)
> Flebit, et insignis tota cantabitur urbe.

Accordingly, he replied in a pamphlet, bearing the title, "Remarks on the statement of Dr Charles Combe, by an occasional writer in the British Critic, 1795." It is written in a temperate, calm, and guarded tone; the sarcastic asperity of its author might have inflicted, and the provocation would have justified, a much severer castigation than the rash delinquent was doomed to endure.

In the year 1800, by the appointment of Mr Alderman Combe, lord mayor of London, Dr Parr preached the celebrated Spital sermon in Christ-Church. Capacious as the building is, it was crowded to excess by an intelligent audience, who, for nearly two hours, listened with the most profound attention to the speaker's convincing arguments and resistless eloquence. This elaborate discourse may be regarded as a continuation and extension of those in which he had previously with great ability advocated the cause of general education; and in the course of it the author combats, with irresistible effect, the delusive metaphysics of those philosophers who resolve benevolence and justice into the principle of selfishness. Soon after its delivery, this very original and almost unrivalled composition was printed and published, exhibiting the extraordinary proportion of fifty-one pages occupied with text, and 212 with notes. It called forth some observations from Mr Godwin, the author of "Political Justice," in an octavo pamphlet, entitled "Thoughts occasioned by the perusal of Dr Parr's Spital Sermon, being a reply to Dr Parr, Mr Mackintosh, and others." The author of this tract, who knew as well as any man could do Dr Parr's political leanings and opinions, states in one sentence, written whilst his mind was soured by displeasure and chagrin, what is quite sufficient to refute the charge too often made, and too readily believed, that he was the abetter of revolutionary and democratic principles. "I have always found him," says Mr Godwin, "the advocate of old establishments, and, what appeared to me, old abuses." Parr was ardently desirous to see the condition of mankind meliorated by gradual improvements in their civil and social condition; but he was at the same time, in all its interests, a warm admirer of the British constitution in church and state.

In 1802, Sir Francis Burdett presented him to the rectory of Graffham in Huntingdonshire. The generosity which the baronet exhibited on this occasion is highly creditable to his character, and the value of the gift to the receiver of it must have been immeasurably enhanced by the fine tact and delicacy with which it was conferred. In the letter in which he makes the unsolicited offer, he observes, that a great motive to make it was, that he believed he could do nothing more pleasing to his friends, Mr Fox, Mr Sheridan, and Mr Knight; thus making the appointment in a great measure a favour conferred by those personal friends whom Parr most highly esteemed. Nor is the allusion in his reply to the part of Burdett's letter just referred to less honourable to the author's heart. "Most assuredly I shall myself set a higher value upon your kindness, when I consider it as intended to gratify the friendly feelings of those excellent men, as well as to promote my own personal happiness." He continued, however, to reside at Hatton, where he was greatly esteemed by his parishioners, and had made such additions to his house as to render it peculiarly suited to his convenience and wishes.

On the renewal of the war with France in the year 1803, he published his sermon, "preached on the late fast, October 19, at the parish church of Hatton." It is a noble discourse, well calculated to rouse his hearers, and the nation generally, to heroic and determined resistance against the threatened invasion by the French.

His next publication, and the last that is entitled to particular notice, "Characters of the late Charles James Fox, selected, and in part written, by Philopatris Varvicensis," appeared in 1809. It consists partly of extracts from the various public journals, and is partly of an original character, addressed in the form of an epistle to Mr Coke, with an additional volume of notes. This work, in which the great statesman, his principles and powers of mind, are delineated with much beauty and effect, remains a noble monument of his worth, and of the talents and warm affection of his devoted and enthusiastic panegyrist.

Dr Parr was twice married; in 1771 to Miss Jane Marsingale, who died on the 9th of April 1810; and again, in 1817, to Miss Eyre, sister of the Reverend James Eyre of Coventry. Of his children, one died at Norwich, and another, Catherine, fell a victim to consumption at Teignmouth in 1805. A third, Sarah, was married to Mr Wynne of Plasnewydd, Denbighshire, but she also died early.

In 1823, his strength began visibly to decline; and his spirits ceased to display their wonted elasticity and animation. On Sunday the 16th of January 1825 he performed all the duties of the church at Hatton; but was, in the course of the following night, seized with severe fever and delirium. From that period his vital powers gradually declined; but he bore his sufferings with patient fortitude and pious resignation; and on the evening of Sunday the 6th of March 1825 gently expired, having on the 26th of January completed the seventy-eighth year of his age. His remains were deposited in a vault of Hatton Church; and Dr Butler, archdeacon of Derby, and head master of Shrewsbury School, preached the funeral sermon, from the text which Dr Parr had directed to be inscribed on his monument: *What doth the Lord require of thee, but to do justly, and to love mercy, and to walk humbly with thy God?*

Dr Parr was endowed by nature with a powerful intellect and retentive memory; in argument he was keen and irresistible; but he was opinionative, strong in his likings and aversions, and impatient of opposition. In politics he displayed the most ardent love of freedom, the most incorruptible integrity, and resolute independence. In learning he was perhaps unrivalled by any other individual of the age in which he lived; as a classical scholar he was not surpassed; he excelled in metaphysics and moral philosophy; and in theology he had read extensively and thought deeply. Benevolence and charity, especially to young men of promising talents, whose means were inadequate to their support, were pre-eminent qualities of his frank and generous heart. He was full of truth and integrity, and his piety, though unostentatious, was fervent and sincere. (A. R. C.)

Parr, *Thomas*, a remarkable Englishman, who lived in the reigns of ten kings and queens, and having married a second wife when he was 120, had a child by her. He was the son of John Parr, a husbandman of Winnington, in the parish of Alderbury, in the county of Salop, where he was born in the year 1483. Though he lived to the great age of upwards of 152 years, yet the tenor of his life admitted of but little variety; nor can the detail of it be considered as of importance, further than what may arise from the gratification of that curiosity which naturally inquires after the mode of living which could lengthen life to such extreme old age. Following the profession of his father, he laboured hard, and lived on coarse fare. Taylor, the water poet, says of him:

> Good wholesome labour was his exercise,
> Down with the lamb, and with the lark would rise;
> In mire and toiling sweat he spent the day,
> And to his team he whistled time away:
> The cock his night-clock, and, till day was done,
> His watch and chief sun-dial was the sun.

And the same writer observes of him, that

> From head to heel, his body had all over
> A quick set, thick set, natural hairy cover.

The manner of his being conducted to London is also noticed in the following terms: "The Right Honourable Thomas earl of Arundel and Surrey, earl marshal of England, on being lately in Shropshire to visit some lands and manors which his lordship holds in that county, or for some other occasions of importance which caused his lordship to be there, the report of this aged man was signified to his honour; who hearing of so remarkable a piece of antiquity, his lordship was pleased to see him; and in his innate, noble, and Christian piety, he took him into his charitable tuition and protection, commanding that a litter and two horses (for the more easy carriage of a man so feeble and worn with age) to be provided for him; also, that a daughter of his, named Lucy, should likewise attend him, and have a horse for her own riding with him; and to cheer up the old man, and make him merry, there was an antique-faced fellow, with a high and mighty nobeard, that had also a horse for his carriage. These were all to be brought out of the country to London by easy journeys, the charge being allowed by his lordship; likewise one of his lordship's own servants, named Bryan Kelly, to ride on horseback with them, and to attend and defray all manner of reckonings and expenses." All this was accordingly done.

"Winnington is a parish of Alderbury, near a place called the Welch Pool, eight miles from Shrewsbury; from whence he was carried to Wem, a town of the earl's aforesaid; and the next day to Shiffnall, a manor-house of his lordship's, where they likewise stayed one night: from Shiffnall they came to Wolverhampton, and the next day to Birmingham, and from thence to Coventry. Although Master Kelly had much to do to keep the people off that pressed upon him in all places where he came, yet at Coventry he was most oppressed, for they came in such multitudes to see the old man, that those who defended him were almost quite tired and spent, and the aged man in danger of being stifled; and, in a word, the rabble were so unruly, that Bryan was in doubt he should bring his charge no farther; so greedy are the vulgar to hearken to or gaze after novelties. The trouble being over, the next day they passed to Daintree, to Stony Stratford, to Radburne, and so to London; where he was well entertained and accommodated with all things, having all the foresaid attendance at the sole charge and cost of his lordship." When brought before the king, his majesty, with more acuteness than good manners, said to him, "You have lived longer than other men, what have you done more than other men?" He answered, "I did penance when I was a hundred years old." This journey, however, proved fatal to him. Owing to the alteration in his diet, the change of the air, and his general mode of life, he lived but a very short time; and having died on the 5th of November 1635, he was buried in Westminster Abbey. After his death, his body was opened; and an account of the *post mortem* examination was drawn up by the celebrated Dr Harvey.

"Thomas Parr," says that great physician, "was a poor country man of Shropshire, whence he was brought up to London by the Right Honourable Thomas earl of Arundel and Surrey; and died after he had outlived nine princes, in the tenth year of the tenth of them, at the age of 152 years and nine months.

"He had a large breast, lungs not fungous, but sticking to his ribs, and distended with blood; a lividness in his face, as he had a difficulty of breathing a little before his death, and a long lasting warmth in his armpits and breast after it; which sign, together with others, were so evident in his body, as they use to be on those that die by suffocation. His heart was great, thick, fibrous, and fat. The blood in the heart blackish and diluted. The cartilages of the sternum not more bony than in others, but flexile and soft. His viscera were sound and strong, especially the stomach; and it was observed of him, that he used to eat often by night and day, though contented with old cheese, milk, coarse bread, small beer, and whey; and, which is more remarkable, that he ate at midnight a little before he died. His kidneys were covered with fat, and pretty sound; only on the interior surface of them were found some aqueous or serous abscesses, whereof one was near the bigness of a hen egg, with a yellowish water in it, having made a roundish cavity, impressed on that kidney; whence some thought it came that a little before his death a suppression of urine had befallen him, though others were of opinion that his urine was suppressed upon the regurgitation of all the serosity into his lungs. Not the least appearance there was of any stony matter either in the kidneys or bladder. His bowels were also sound, a little whitish without. His spleen very little, hardly equalling the bigness of one kidney. In short, all his inward parts appeared so healthy, that if he had not changed his diet and air, he might perhaps have lived a good while longer. The cause of his death was imputed chiefly to the change of food and air; forasmuch as coming out of a clear, thin, and free air, he came into the thick air of London; and after a constant plain and homely country diet, he was taken into a splendid family, where he fed high and drank plentifully of the best wines, whereupon the natural functions of the parts of his body were overcharged, his lungs obstructed, and the habit of the whole body quite disordered; upon which there could not but ensue a dissolution. His brain was sound, entire, and firm; and though he had not the use of his eyes, nor much of his memory, several years before he died, yet he had his hearing and apprehension very well; and was able, even to the 130th year of his age, to do any husbandman's work, even thrashing of corn."

PARRELS, in a ship, are frames made of trucks, ribs, and ropes, which, having both their ends fastened to the yards, are so contrived as to go round the masts, that by their means the yards may move up and down upon the mast. The parrels also, along with the breast-ropes, fasten the yards to the masts.

PARRHASIUS, a celebrated painter, the son of Evenor, was a native of Ephesus, and flourished in the year 397 before Christ, being the contemporary of Zeuxis, Eupompus, and Timanthes. He was the first who succeeded in giving the proper proportion to his figures, in throwing the expression of the passions into the countenance, and in causing the figure to appear to start from the canvass. Several who had preceded him were successful in finishing particular parts, but none could rival him in putting the whole together. Zeuxis was the only one of his contemporaries who at all approached him, and even he was at last obliged to acknowledge his inferiority. (See Zeuxis.) One of his most curious paintings was a representation of the Demos of Athens, in which he had contrived to exhibit all the various passions with which that celebrated people were affected. His painting of the Hoplites, or the armed man running, had the effect of a person perspiring from excessive exertion; and another who was taking off his arms seemed to be panting for breath. Parrhasius was, like Zeuxis, distinguished for his vanity and arrogant mode of life. He used to wear a purple dress, a golden crown on his head, to hold in his hand a staff studded with golden nails, and to wear golden latchets to his shoes (Ælian. *Var. Hist.* ix. 11). He was once beaten by Timanthes, in the subject of Ajax disputing with Ulysses respecting the arms of Achilles (Plin. xxxv. 36, 7–11; Athen. xii. 543, e. d. xv. 687, b. c.).

Parrhasius, *Janus*, a famous grammarian in Italy, who was born at Cosenza, in the kingdom of Naples, in the year 1470. He was intended for the law, the profession of his ancestors; but he refused to pursue it, and cultivated classical learning. His real name was Johannes Paulus Parisius; but, according to the practice of the grammarians of the age, he took instead of it that of Parrhasius. He taught at Milan with much reputation, being admired for a graceful delivery, in which he chiefly excelled other professors. It was this charm in his voice which brought a vast concourse of people to his lectures; and, amongst others, he had the pleasure of seeing General Trimoles, who was then threescore years of age. He went to Rome when Alexander VI. was pope, and had nearly been involved in the misfortunes of Bernardini Cajetan and Silius Savello, with whom he had some correspondence; but he escaped the danger, by the information of Thomas Phœdrus, professor of rhetoric, and canon of St John Lateran, whose advice he followed by retiring from Rome. Soon afterwards, he was appointed public professor of rhetoric at Milan; but the liberty which he took in censuring the teachers there as arrant blockheads provoked them in return to asperse his morals. He, in consequence, went to Vicenza, where he obtained a larger salary; and he held this professorship till the states of the Venetians were laid waste by the troops of the League; upon which he went to his native country, having made his escape through the army of the enemy. He was at Cosenza when his old friend Phœdrus persuaded Julius to send for him to Rome; and although that design proved abortive by the death of the pope, yet, on the recommendation of John Lascaris, he was called thither under Leo X. the successor of Julius. Leo was before favourably inclined towards him, and on his arrival at Rome appointed him professor of polite literature. He had been now some time married to a daughter of Demetrius Chalcondylas; and he took with him to Rome, Basil Chalcondylas, brother of Demetrius Chalcondylas, professor of the Greek tongue at Milan. But he did not long enjoy the office which had been conferred upon him by the pope; for, worn out by his studies and labours, he became so afflicted with the gout, that for some years there was no part of his body unaffected except his tongue. He left Rome and returned to Calabria, his native country, where he at last died in the greatest misery. Several works have been ascribed to him.

PARRIAH, a town of Hindustan, in the province of Bahar, and district of Tirhoot. There was formerly a fort here, as a defence against the incursions of the natives from the northern hills. Long. 85. 52. E. Lat. 26. 41. N.

PARRICIDE, the murder of one's parents or children. By the Roman law, this crime was punished in a much more severe manner than any other kind of homicide. The delinquents, after being scourged, were sewed up in a leathern sack, with a live dog, a cock, a viper, and an ape, and were then cast into the sea. Solon, it is true, in his laws, made none against parricide, apprehending it impossible that any one could be guilty of so unnatural a barbarity; and the Persians, according to Herodotus, entertained the same notion, when they adjudged all persons who killed their reputed parents to be bastards.

PARROT Islands, a cluster of islands in Dusky Bay, New Zealand, three miles south-west from Facile harbour.

PARSON *and* Vicar, in the Church of England. A parson, *persona ecclesiæ*, is one who has full possession of all the rights of a parochial church. He is called parson, *persona*, because by his person the church, which is an invisible body, is represented; and he is in himself a body corporate, in order to protect and defend the rights of the church, which he personates, by a perpetual succession. He is sometimes called the *rector* or governor of the church; but the appellation of *parson*, however it may be depreciated by familiar and indiscriminate use, is the most legal and most honourable title that a parish priest can enjoy; because such a one, as Sir Edward Coke observes, and he alone, is said *vicem seu personam ecclesiæ gerere*. A parson has, during his life, the freehold in himself of the parsonage-house, the glebe, the tithes, and other dues. But these are sometimes appropriated; that is to say, the benefice is perpetually annexed to some spiritual corporation, either sole or aggregate.

The appropriating corporations, or religious houses, were wont to depute one of their own body to perform divine service, and administer the sacraments, in those parishes of which the society was thus the parson. This officiating minister was in reality no more than a curate, deputy, or vicegerent of the appropriator, and was therefore called *vicarius*, or vicar. His stipend was at the discretion of the appropriator, who was, however, bound of common right to find somebody, *qui illi de temporalibus, episcopo de spiritualibus, debeat respondere.* But this was done in so scandalous a manner, and the parishes suffered so much by the neglect of the appropriators, that the legislature was forced to interpose; and accordingly it was enacted, by statute 15 Richard II. c. 6, that in all appropriations of churches the diocesan bishop should ordain, in proportion to the value of the church, a competent sum to be distributed amongst the poor parishioners annually, and to provide that the vicarage should be sufficiently endowed. It seems that the parish were frequent sufferers, not only by the want of divine service, but also by the withholding of those alms for which, amongst other purposes, the payment of tithes was originally imposed; and therefore in this act a pension was directed to be distributed amongst the poor parochians, as well as a sufficient stipend to the vicar. But he, being liable to be removed at the pleasure of the appropriator, was not likely to insist too rigidly upon the legal sufficiency of the stipend; and, therefore, by statute 4 Henry IV. c. 12, it was ordained that the vicar should be a secular person, not a member of any religious house; that he should be vicar perpetual, not removeable at the caprice of the monastery; and that he should be canonically instituted and inducted, and be sufficiently endowed, at the discretion of the ordinary, to do divine service, to inform the people, and to show hospitality. In consequence of these statutes, the endowments have usually been by a portion of the glebe, or land belonging to the parsonage, and a particular share of the tithes, which the appropriators found it most troublesome to collect, and which are therefore generally called *petty* or *small tithes;* the greater, or predial tithes, being still reserved for their own use. But the same rule was not observed in the endowment of all vicarages. Hence some are more liberally, and others more scantily, endowed; and hence the tithes of many things, as wood in particular, are in some parishes rectorial, and in others vicarial, tithes.

The distinction therefore between a parson and vicar is this. The parson has for the most part the whole right to all the ecclesiastical dues in his parish; but a vicar has generally an appropriator over him, who is entitled to the best part of the profits, and to whom he is in effect perpetual curate, with a standing salary. The method of becoming a parson or vicar is much the same. To both there are four necessary requisites; holy orders, presentation, institution, and induction.

PARSONAGE, a rectory or parish church, endowed with a glebe, house, lands, and tithes, for the maintenance of a minister, with cure of souls within the parish.

PARSONAUTH, a town of Hindustan, in the province of Bahar, situated amongst the hills, between Bahar and Bengal. It is held in great estimation by the Jains, as a remarkably holy place. One of the principal deities is named Pariswanath, the real founder of the sect, who died at the age of a hundred years.

PART is a portion of a whole, considered as divided or divisible.

Logical Part is a division for which we are indebted to the schoolmen. It refers to some universal as its whole; in which sense the species are parts of a genus, and individuals or singulars are parts of the species.

Physical Part is that which, though it enter into the composition of a whole, may yet be considered apart, and under its own distinct idea; and in this sense a *continuum* is said to consist of parts. Physical parts, again, are of two kinds, homogeneous and heterogeneous. The first are those of the same denomination with some other; the second are of a different denomination. Parts, again, are distinguished into subjective, essential, and integrant; a division of which the schoolmen were likewise the authors.

Aliquot Part is a quantity which, being repeated any number of times, becomes equal to an integer. Thus 6 is an aliquot part of 24, and 5 an aliquot part of 30.

Aliquant Part is a quantity which, being repeated any number of times, becomes always either greater or less than the whole. Thus 5 is an aliquant part of 17, and 9 is an aliquant part of 10. The aliquant part is resolvable into aliquot parts. Thus 15, an aliquant part of 20, is resolvable into 10, a half, and 5, a fourth part, of the same number.

PARTALPOOR, a town of Bengal, in the district of Midnapoor. Long. 87. 50. E. Lat. 22. 21. N.

PARTANNA, a city of the intendency of Trapani, in the district of Mazzara, in the island of Sicily. It stands on a hill, about eight miles from the sea, in a healthy situation, fifty miles from Palermo, and contains 7100 inhabitants, employed in growing cotton wool, and in feeding black cattle.

PARTERRE, in *Gardening*, a level division of ground, which for the most part faces the south or best front of a house, and is generally furnished with evergreens, shrubs, and flowers.

PARTHENAY, an arrondissement of the department of the Two Sèvres, in France, extending over 683 square miles. It comprehends eight cantons, divided into forty-six communes, and containing 55,300 inhabitants. The capital is the city of the same name, situated on the river Thoué. It was one of the chief seats of the Vendean war, and suffered most severely. It contains 800 houses, and 3600 inhabitants. Long. 0. 19. W. Lat. 46. 40. N.

PARTHIA, a celebrated empire of antiquity, bounded on the west by Media, on the north by Hyrcania, on the east by Aria, and on the south by Caramania. It was surrounded on every side by mountains, which still serve as its boundaries, though the name is now changed. According to Ptolemy, Parthia was divided into five districts; Caminsine or Gamisene, Partheyne, Choroane, Atticene, and Tabiene. The ancient geographers enumerate a great many cities in this country. Ptolemy, in particular, reckons twenty-five large ones; and it must have been very populous, since we have accounts of two thousand villages, besides several cities, which were destroyed by earthquakes. Its capital was named *Hecatompolis*, so called from the circumstance of its having a hundred gates.

The history of the ancient Parthians is involved in obscurity. All we know about them is, that they were first subject to the Medes, then to the Persians, and lastly to Alexander. After the death of the Macedonian conqueror, the province fell to Seleucus Nicator, and was held by him and his successors till the reign of Antiochus Theus, about two centuries and a half before Christ. At this time the Parthians revolted, and chose Arsaces as their king. Seleucus Callinicus, the successor of Antiochus Theus, attempted to reduce Arsaces; but the latter, having had time to strengthen himself, defeated his antagonist, and drove him out of the country. In a short time, however, Seleucus undertook another expedition against Arsaces, which proved still more unfortunate than the former; for being defeated in a great battle, he was taken prisoner, and died in captivity. The day upon which Arsaces gained this victory was ever afterwards observed amongst the Parthians as an extraordinary festival. Arsaces being thus established in his new kingdom, reduced Hyrcania and several other provinces; but he was at last killed in a battle against Ariarathes, king of Cappadocia. From this prince all the other kings of Parthia took the surname of *Arsaces*, as those of Egypt did that of *Ptolemy* from Ptolemy Soter.

Arsaces was succeeded by his son, who, having entered Media, made himself master of that country, whilst Antiochus the Great was engaged in war with Ptolemy Euergetes, king of Egypt. Antiochus, however, had no sooner found himself disengaged from that war, than he marched with all his forces against Arsaces, and at first drove him completely out of Media. But the latter soon returned with an army of a hundred thousand foot and twenty thousand horse, with which he put a stop to the progress of Antiochus; and a treaty was soon afterwards concluded, by which it was agreed that Arsaces should remain master of Parthia and Hyrcania, upon condition of assisting Antiochus in his wars with other nations.

Arsaces II. was succeeded by his son Priapatius, who reigned fifteen years, and left three sons; Phrahates, Mithridates, and Artabanus. Phrahates, the elder, succeeded to the throne, and reduced the Mardians, who had never been conquered by any but Alexander. His brother Mithridates, who was invested with the regal dignity, reduced the Bactrians, Medes, Persians, and Elymeans, and overran a great part of the East, penetrating beyond the boundaries of Alexander's conquests. Demetrius Nicator, who then reigned in Syria, endeavoured to recover these provinces; but his army was entirely destroyed, and he himself taken prisoner, in which state he remained till his death. After this victory Mithridates made himself master of Babylonia and Mesopotamia, so that all the provinces between the Euphrates and the Ganges were now subject to his sway.

Mithridates died in the thirty-seventh year of his reign, leaving the throne to his son Phrahates II. But the latter was scarcely settled in his kingdom when Antiochus Sidetes marched against him at the head of a numerous army, on the pretence of delivering his brother Demetrius, who was still detained in captivity. Phrahates was defeated in three pitched battles, in which he lost all the countries conquered by his father, and was reduced within the limits of the ancient Parthian kingdom. Antiochus, however, did not long enjoy his good fortune; for his numerous army being obliged to separate to such distances as prevented them, in case of any sudden attack, from reuniting, the inhabitants, whom they had cruelly oppressed, took advantage of this separation, and conspired with the Parthians to destroy them. And this they accordingly effected. The vast army of Antiochus, with the monarch himself, were slaughtered in one day, scarcely a single person having escaped to carry the news to Syria. Phrahates, elated with this success, proposed to invade Syria; but happening to quarrel with the Scythians, he was cut off with his whole army by that people.

Phrahates was succeeded by his uncle Artabanus. The new king, however, enjoyed his dignity for a very short time, being, a few days after his accession, killed in another battle with the Scythians. He was succeeded by Pacorus, who entered into an alliance with the Romans, and was, in his turn, succeeded by Phrahates III. This monarch took under his protection Tigranes, the son of Tigranes the Great, king of Armenia, gave the young prince his daughter in marriage, and invaded the kingdom with a design to place him on the throne of Armenia; but on the approach of Pompey he thought proper to retire, and soon afterwards solemnly renewed the treaty with the Romans. Phrahates was murdered by his children, Mithridates and Orodes; and soon afterwards the former was put to death by his brother, who thus became the sole master of the Parthian empire.

In his reign happened the memorable war with the Romans under Crassus. This was occasioned, not by any breach of treaty on the part of the Parthians, but by the shameful avarice of Crassus. At that time the Roman empire had been divided between Cæsar, Pompey, and Crassus; and in virtue of this partition, the eastern provinces had fallen to the lot of Crassus. No sooner was he invested with his new dignity, than he resolved to carry the war into Parthia, hoping to enrich himself with the spoils of a people who were then accounted wealthy. As the Parthians had religiously observed the treaty, some of the tribunes opposed him; but Crassus having, by the assistance of Pompey, carried every thing before him, left Rome in the year 55 before Christ, and pursued his march to Brundusium, where he immediately embarked his troops, and after a difficult passage reached the ports of Galatia. From Galatia Crassus hastened to Syria, and, in passing through Judea, plundered the temple of Jerusalem. He then marched to the river Euphrates, which he crossed on a bridge of boats, and, having entered the Parthian dominions, began hostilities. As the enemy had not expected an invasion, they were quite unprepared for resistance. Hence Crassus overran all Mesopotamia; and if he had taken advantage of the consternation into which the Parthians were at first thrown, he might also have reduced Babylonia. But instead of this he repassed the Euphrates early in the autumn, leaving only seven thousand foot and one thousand horse to garrison the places he had reduced; and having put his army into winter quarters in Syria, he gave himself wholly up to his favourite passion of amassing money.

Early in the ensuing spring, the Roman general drew out his forces, in order to pursue the war with vigour; but, during the winter, Orodes had collected a numerous army, and was well prepared to oppose him. Before he entered upon action, however, the Parthian monarch sent ambassadors to Crassus, to expostulate with him on his injustice in attacking an ally of the Roman empire; but Crassus, without attending to their representations, merely replied, that they should have his answer at Seleucia. Orodes, finding that a war was unavoidable, divided his army into two corps. At the head of one he marched towards Armenia, to oppose the king of that country, who had raised a considerable army to assist the Romans; and the other he sent into Mesopotamia, under the command of Surenas, an experienced general, by whose conduct all the cities which Crassus had reduced were quickly retaken. Some Roman soldiers who made their escape fled to the camp of Crassus, and filled his army with terror by the accounts they gave of the number, power, and strength, of the enemy. They stated that the Parthians were numerous, brave, and well disciplined; that it was impossible to overtake them when they fled, or escape from them when they pursued; that their defensive weapons were proof against the Roman darts, and their offensive weapons so sharp, that no buckler could resist them. Crassus looked upon all this as the effect of sheer cowardice. But the common soldiers, and even many of the officers, were so disheartened, that Cassius, who afterwards conspired against Cæsar, and most of the legionary tribunes, advised Crassus to suspend his march, and consider better of the enterprise before he proceeded farther. Crassus, however, obstinately persisted in his resolution, being encouraged by the arrival of Artabazus, king of Armenia, who brought with him six thousand horse, and promised to send ten thousand cuirassiers and thirty thousand infantry whenever he should stand in need of them. At the same time the latter advised the Roman general not to march his army through the plains of Mesopotamia, but to penetrate through the mountains of Armenia. He stated, that, as Armenia was a mountainous country, the enemy's cavalry, in which their main strength consisted, would there be entirely useless, and that the Roman army, in penetrating through this country, would be plentifully supplied with all manner of necessaries; whereas, if the general marched through Mesopotamia, he would be perpetually harassed by the Parthian horse, and frequently be obliged to lead his army through sandy deserts, where he would be distressed for want of water, and every kind of provisions. This salutary advice, however, was rejected, and Crassus entered Mesopotamia with an army amounting to forty thousand men.

The Romans had no sooner crossed the Euphrates than Cassius advised his general to advance to some of those towns in which the garrisons still remained, in order to halt and refresh his troops; or, if he disapproved of this, to march along the banks of the Euphrates to Seleucia, by which means he would prevent the Parthians from surrounding him, at the same time that he would be plentifully supplied with provisions from his ships. Crassus seemed to approve of this judicious advice; but he was dissuaded by Abgarus, king of Edessa, whom the Romans took for an ally, though he was in reality a traitor sent by Surenas to effect the destruction of the Roman army. Under the conduct of this faithless guide, the Romans entered a vast plain divided by many rivulets. Their march through this fine country proved easy; but the farther they advanced the worse the roads became, insomuch that they were at last obliged to climb up rocky mountains, which brought them to a dry and sandy plain, where they could find neither food to satisfy their hunger, nor water to quench their thirst. Abgarus then began to be suspected by the tribunes and other officers, who earnestly entreated Crassus not to follow him any longer, but to retreat towards the mountains; and at the same time an express arrived from Artabazus, informing the Roman general that Orodes had invaded his dominions with a great army, and that he was obliged to keep his troops at home to defend his own dominions. The same messenger advised Crassus, in his master's name, to avoid the barren plains, where his army would certainly perish with hunger and fatigue, and to approach Armenia, that they might unite their forces against the common enemy. But all was to no purpose. Crassus, instead of hearkening either to the advice of the king or to his own officers, first flew into a violent rage with the messengers of Artabazus, and then told his troops, that they were not to expect the delights of Campania in the most remote parts of the world.

They accordingly continued their march for several days across a desert, the very sight of which was sufficient to fill them with despair. They could not perceive, either near or at a distance, the least tree, plant, or brook, nay, not so much as a hill, or a single blade of grass; all around, nothing was to be seen but huge heaps of burning sand. The Romans had scarcely penetrated through this desert, when intelligence was brought them by their scouts, that a numerous army of Parthians was advancing in full march to attack them. In fact, Abgarus, on pretence of going out on parties, had often conferred with Surenas, and with him concerted measures for destroying the Roman army. Upon receiving this intelligence, which occasioned great confusion in the camp, the Romans being quite exhausted with their long and troublesome march, Crassus drew up his men in order of battle, at first following the advice of Cassius, who recommended extending the infantry as widely as possible, that they might occupy the more ground, and thus prevent the enemy from surrounding them. But Abgarus having assured the proconsul that the Parthian forces were not so numerous as had been represented, he changed this disposition, and, believing only the man who betrayed him, drew up his troops in a square, which faced every way, having on each side twelve cohorts in front; and near to each cohort he placed a troop of cavalry to support them, that they might charge with the greater security and boldness. Thus the whole army looked more like one phalanx than troops drawn up in manipules, with intervening spaces, according to the usual Roman formation. The general himself commanded the centre, his son had charge of the left wing, and to Cassius was committed the right.

In this order they advanced to the banks of a small river called the Balissus, the sight of which was very agreeable to the soldiers, who were much harassed with drought and excessive heat. When they came in sight of the enemy, they did not appear to be either so numerous or so terrible as had been represented. But this was a stratagem of Surenas, who had concealed his men in convenient places, ordering them to cover their arms, lest their brightness should betray them, and to start up at the first signal and attack the enemy on all sides. The stratagem had the desired effect. No sooner had Surenas given the signal, than the Parthians, rising as it were out of the ground, with dreadful yells advanced against the Romans, who were greatly surprised, not to say dismayed, at the sight; the more so as the Parthians, throwing off the covering of their arms, appeared in shining cuirasses, and helmets of burnished steel, finely mounted on horses covered all over with armour of the same metal. At their head appeared in a rich dress young Surenas, who immediately charged the enemy, endeavouring, by means of his pikemen, to break through the first rank of the Roman army; but finding it too close and impenetrable, the cohorts supporting each other, he fell back, and retired in seeming confusion. The Romans, however, were much surprised when they saw themselves suddenly surrounded on all sides, and galled with continual showers of arrows. Crassus ordered his light-armed foot and archers to advance and charge the enemy; but they were soon repulsed, and forced to cover themselves behind the heavy-armed infantry. Then the Parthian horse, advancing near the Romans, discharged upon them showers of arrows, every one of which did execution, owing to the close order in which the legionaries had been drawn up. Their arrows, too, were of an extraordinary weight, and discharged with such force that nothing was proof against them. The two wings advanced in good order to repulse them, but without effect. The Parthians shot their arrows with as great dexterity when their backs were turned as when they faced the enemy; so that the Romans, whether they kept their ground or pursued the flying enemy, were equally annoyed with their fatal missiles.

The Romans, as long as they had any hopes that the Parthians, after having spent their arrows, would either betake themselves to flight, or engage them hand to hand, stood their ground with great resolution and intrepidity. But when they observed that there were a great many camels in their rear loaded with arrows, and that those who emptied their quivers wheeled about to fill them anew, they began to lose courage, and to complain loudly of their general for suffering them thus to stand still, and serve only as a butt to the enemy's missiles, which, they perceived, would not be exhausted till they were all killed to a man. Upon this Crassus ordered his son to advance, at all hazards, and attack the enemy with thirteen hundred horse, five hundred archers, and eight cohorts. But the Parthians no sooner saw this choice body, the flower of the army, marching against them, than they wheeled about, and, according to their usual custom, betook themselves to flight. Young Crassus, crying out as loud as he could, "They fly before us," pushed on after them at full speed, not doubting that he should gain a complete victory. But when he was at a considerable distance from the main body of the Roman army, he perceived his mistake; for those who had before fled now faced about and charged him with incredible fury. Young Crassus ordered his troops to halt, hoping that the enemy, upon seeing their small number, would not be afraid to come to a close fight. But herein he was likewise disappointed; for the Parthians, contenting themselves to oppose his front with their heavy-armed horse, surrounded him on all sides, and, keeping at a distance, discharged incessant showers of arrows upon the unfortunate Romans. The Parthian army, in wheeling about, raised so thick a dust that the Romans could scarcely perceive one another, much less the enemy; nevertheless, they found themselves wounded with arrows, though they could not discover whence they came. In a short time the ground on which they stood was covered with dead bodies.

In this desperate condition, Crassus, observing a rising ground at a small distance, led the remains of his detachment thither, with a design to defend himself in the best manner he could, till succours should be sent to him by his father. The Parthians pursued him, and, having surrounded him in his new post, continued showering arrows upon his men, till most of them were either killed or disabled, without being able to make use of their arms, or to give the enemy proofs of their valour.

Young Crassus had with him two Greeks, who had settled in the city of Carrhæ. Touched with compassion at seeing so brave a man reduced to such straits, they pressed him to retire with them to the neighbouring city of Ischnes, which had declared for the Romans; but the young Roman rejected their proposal with indignation, telling them that he would rather die a thousand times than abandon so many valiant men, who sacrificed their lives for his sake. Having returned this answer to his Grecian friends, he embraced and dismissed them, giving them leave to retire and to shift for themselves in the best manner they could. As for himself, having now lost all hopes of being relieved, and seeing most of his men killed round him, he gave way to his grief; and, not being able to make use of his arm, which was shot through with a large barbed arrow, he presented his side to one of his attendants, and ordered him to put an end to his unhappy life. His example was followed by Censorius, a senator, by Megabacchus, a brave and experienced officer, and by most of the nobility who served under him. Five hundred common soldiers were taken prisoners, and the rest cut in pieces.

The Parthians, having thus cut off or taken the whole detachment commanded by young Crassus, marched without delay against his father, who, upon the first intelligence that the enemy were flying, closely pursued by his son, had taken heart, the more so because those who had remained to make head against him seemed to abate much of their ardour. Having encouraged his troops, therefore, he had retired to a small hill in his rear, to wait there till his son should return from the pursuit. Young Crassus had despatched frequent expresses to his father, to acquaint the general with his danger; but they had all fallen into the enemy's hands, and only the last, who had escaped with great difficulty, arrived safe, and informed him that his son was lost if he did not send him an immediate and powerful reinforcement. This news threw Crassus into the utmost consternation. A thousand affecting thoughts rose in his agitated mind, and disturbed his reason to such a degree that he scarcely knew what he was doing. However, the desire he had of saving his son, and the many brave Romans who were under his command, induced him immediately to march to their assistance; but he had not advanced far before he was met by the Parthians, who, with loud shouts and songs of victory, gave the unhappy father notice of his misfortune. They had cut off the head of young Crassus, and having fixed it on the point of a lance, were advancing full speed to fall on the father. As they drew near, Crassus was struck with the dismal and affecting spectacle; but though he suffered the deepest affliction, he had the presence of mind to stifle his grief, for fear of discouraging the army, and to cry out to the dismayed troops, "This misfortune is entirely mine; the loss of one man cannot affect the victory. Let us charge, let us fight like Romans; if you have any compassion for a father who has just now lost a son whose valour you admired, let it appear in your rage and resentment against these insulting barbarians." Thus Crassus strove to re-animate his troops; but his efforts proved unsuccessful. Their courage was quite sunk, as appeared from the faint and languishing shout which they raised, according to custom, before the action. When the signal was given, the Parthians, adhering to their usual mode of fighting, discharged on the legionaries clouds of arrows, which did such dreadful execution that many of the Romans, to avoid the arrows, which occasioned a long and painful death, threw themselves, like men in despair, on the enemy's heavy-armed horse, seeking from their spears a more speedy and easy kind of death. Thus the Parthians continued plying them incessantly with their arrows till night, when they left the field of battle, crying out that they would allow the father one night to lament the death of his son.

This was a melancholy night for the Romans. Crassus kept himself concealed from the soldiery, lying in the open air, upon the bare ground, with his head wrapped up in his paludamentum or military cloak, and, in that forlorn condition, exhibiting a great example of the instability of fortune, and a still greater of the pernicious effects of avarice, temerity, and ambition. Octavius and Cassius having approached him, endeavoured to raise him up and console him; but, seeing him quite sunk under the weight of his affliction, and deaf to all comfort, they summoned a council of war, composed of all the chief officers, in which it was unanimously resolved that they should decamp before break of day, and retire, without sound of trumpet, to the neighbouring city of Carrhæ, which was held by a Roman garrison. Agreeably to this resolution, they commenced their march as soon as the council broke up, which produced dreadful outcries amongst the sick and wounded, who, perceiving that they were to be abandoned to the mercy of the enemy, filled the camp with their complaints and lamentations. But their cries and tears, though very affecting, did not stop the march of the others, which, indeed, was very slow, in order to give the stragglers time to come up. There were only three hundred light horse, under the command of Ægnatius, who pursued their march without stopping, and arrived at Carrhæ about midnight. Ægnatius, calling to the centinels on the walls, desired them to acquaint Coponius, the governor of the place, that Crassus had fought a great battle with the Parthians; and, without saying a word more, or letting him know who he was, continued his march with all possible expedition to the bridge of Zeugma, which he passed, and by that means saved his troops. But he was much blamed for thus abandoning his general at so critical a moment.

The message which he sent to Coponius was of some temporary service to Crassus. For that commander, wisely conjecturing, from the manner in which the unknown person had given him the intelligence, that some misfortune had befallen Crassus, immediately ordered his garrison to stand to their arms; and having marched out, met Crassus, whom he conducted, with the remains of his army, into the city. The Parthians, though informed of his flight, did not offer to pursue him, observing therein the superstitious custom which obtained amongst them and the Persians, not to fight in the night; but when it was day, they entered the Roman camp, and having put all the wounded, to the number of about four thousand, to the sword, dispersed their cavalry all over the plain, in pursuit of the fugitives. One of the lieutenants of Crassus, named Vargunteius, having separated in the night from the main body of the army, with four cohorts, missed his way, and was overtaken by the enemy. At their approach he withdrew to a neighbouring hill, where he defended himself, with great valour, till all his men were killed, excepting twenty, who made their way through the enemy, sword in hand, and got safe to Carrhæ; but Vargunteius himself lost his life on the occasion.

In the mean time Surenas, not knowing whether Crassus and Cassius had retired to Carrhæ or chosen a different route, in order to be informed of the truth, and take his measures accordingly, despatched a messenger, who spoke the Roman language, to the city of Carrhæ, enjoining him to approach the walls, and acquaint Crassus himself, or Cassius, that the Parthian general was inclined to enter into a treaty with them, and demanded a conference. Both the proconsul and his quæstor Cassius spoke with the messenger from the walls; and, accepting the proposal with great joy, desired that the time and place for an interview might be immediately agreed upon. The messenger withdrew, promising to return quickly with an answer from Surenas. But that general no sooner understood that Crassus and Cassius were in Carrhæ, than he marched thither with his whole army, and, having invested the place, acquainted the Romans, that if they expected any favourable terms, they must deliver up to him Crassus and Cassius in chains. A council of the chief officers was summoned, in which it was thought expedient to retire from Carrhæ that very night, and to seek for another asylum. It was of the utmost importance that none of the inhabitants of Carrhæ should be made acquainted with their design till the moment of its execution; but Crassus, whose whole conduct evidently shows that he was labouring under some strange infatuation, imparted the whole matter in confidence to one Andromachus, choosing him for his guide, and relying injudiciously on the fidelity of a man whom he scarcely knew. Andromachus immediately informed Surenas of the design of the Romans; promising, at the same time, as the Parthians did not engage in the night, to manage matters so that they should not get out of his reach before daybreak. The traitor, pursuant to his promise, led them through many windings and turnings, till at last he brought them into deep marshy grounds, where the infantry were up to the knees in mire. Cassius, suspecting that their faithless guide had led them into those swamps with no good design, refused to follow him any longer; and returning to Carrhæ, took his route towards Syria, which he reached with five hundred horse. Octavius, with five thousand men under his command, being conducted by trusty guides, gained the mountains called by Plutarch and Appian *Sinnaci*, and there intrenched himself before daybreak.

As for Crassus, he was still entangled in the marshes, when Surenas, at sunrise, overtook him, and invested him with his cavalry. The proconsul had with him four cohorts and a small body of horse; and with these, in spite of all opposition, he gained the summit of another hill within twelve furlongs of Octavius, who seeing the danger that threatened his general, flew to his assistance with a small number of his men, and was soon followed by all the rest, who, charging the Parthians with great fury, disengaged Crassus, and obliged the enemy to abandon the hill. Upon the retreat of the enemy, they formed themselves into a hollow square, and, placing Crassus in the middle, made a kind of rampart round him with their bucklers, resolutely protesting, that none of the enemy's arrows should touch their general's body till they were all killed fighting in his defence. Surenas, unwilling to let his prey escape, surrounded the hill, as if he designed to make a new attack; but finding his Parthians very backward, and not doubting but the Romans, when night came on, would pursue their march, and get out of his reach, he had recourse again to artifice, and declared before some prisoners, whom he soon afterwards set at liberty, that he was inclined to treat with the proconsul of a peace, and that it was better to come to a reconciliation with Rome, than to sow the seeds of an eternal war, by shedding the blood of one of her generals.

Agreeably to this declaration, Surenas, as soon as the prisoners were released, advanced towards the hill where the Romans were posted, attended only by some of his officers, and, with his bow unbent, and open arms, invited Crassus to an interview. So sudden a change seemed very suspicious to the proconsul, who therefore declined the interview, till he was forced, by his own soldiers, to intrust his life with an enemy whose treachery they had all experienced. The legionaries flocked round him, and not only abused him in an outrageous manner, but even menaced him if he did not accept of the proposals made by the Parthian general. Seeing, therefore, that his troops were ready to mutiny, the proconsul began to advance, without arms or guards, towards the enemy, after having called the gods and all his officers to witness the violence his troops had offered him, and entreated all who were present, but especially Octavius and Petronius, two of the chief commanders, for the honour of Rome, their common mother, not to mention, after his death, the shameful behaviour of the Roman legionaries. Octavius and Petronius could not resolve to let him go alone, but attended him down the hill, as did likewise some legionaries, keeping at a distance. Crassus was met at the foot of the hill by two Greeks, who, dismounting from their horses, saluted him with great respect, and desired him, in the Greek tongue, to send some of his attendants, who might satisfy him that Surenas, and those who were with him, came without arms. Crassus then sent two brothers, of the Roscian family; but Surenas having caused them to be seized, advanced to the foot of the hill, mounted on a fine horse, and attended by the chief officers of his army. Crassus, who waited for the return of his two messengers, was surprised to see himself confronted by Surenas in person, when he least expected it. The Parthian general, perceiving, as he approached Crassus, that he was on foot, cried out, in a seeming surprise, "What do I see? a Roman general on foot, and we on horseback? Let a horse be brought for him immediately." "You need not be surprised," replied Crassus; "we are come only to an interview, each after the custom of his country." "Very well," answered Surenas, "there shall henceforth be a lasting peace between King Orodes and the people of Rome; but we must sign the articles of it on the banks of the Euphrates, for you Romans do not always remember your conventions." Crassus would have sent for a horse; but a very stately one, with a golden bit, and richly caparisoned, was brought to him by a Parthian, which Surenas presenting to him, "Accept this horse from my hands," said he, "which I give you in the name of my master King Orodes." He had scarcely uttered these words, when some of the king's officers, taking Crassus by the middle, set him upon the horse, which they began to whip with great violence before them, in order to make him quicken his pace. Octavius, offended at this insult, took the horse by the bridle; Petronius and the few Romans who were present seconded him, and all, flocking round Crassus, stopped his horse. The Parthians endeavoured to repulse them, and clear the way for the proconsul, upon which they began to jostle and push one another with great tumult and disorder. At last, Octavius, drawing his sword, killed one of the king's grooms; but, at the same time, another coming behind Octavius, with one blow laid him dead at his feet. Both parties fought with great resolution, the Parthians striving to carry off Crassus, and the Romans to rescue him out of their hands. In this scuffle most of the Romans who came to the conference were killed, and amongst the rest Crassus himself, but whether by a Roman or a Parthian is uncertain. Upon his death, the rest of the army either surrendered to the enemy, or, dispersing in the night, were pursued and put to the sword. The Romans lost in this campaign at least thirty thousand men; of whom twenty thousand were killed, and ten thousand taken prisoners.

When the battle of Carrhæ was fought, King Orodes was in Armenia, where he had made peace with Artabazus. Whilst the two kings were solemnizing their new alliance with expensive and public feasts, Styllaces or Syllaces, a Parthian officer, whom Surenas had sent with the news of his victory, and the head of Crassus as a proof of it, arrived in the capital of Armenia. The transports of joy which Orodes felt at this sight, and the tidings which accompanied it, are not to be expressed; and the lords of both kingdoms, who attended their sovereigns, raised loud and repeated shouts of joy. Syllaces was ordered to give a more particular and distinct account of that memorable action; and when he had done so, Orodes commanded molten gold to be poured into Crassus's mouth, thereby reproaching him with avarice, which had always been his predominant passion.

But Surenas did not long enjoy the pleasure of his victory; for Orodes, jealous of his power and authority amongst the Parthians, soon afterwards caused him to be put to death. Pacorus, the king's favourite son, was placed at the head of the army, and, agreeably to his father's directions, invaded Syria; but he was driven back with great loss by Cicero and by Cassius, the only general who had survived the defeat of Crassus. After this no mention is made of the Parthians till the time of the civil war between Cæsar and Pompey, when the latter sent ambassadors to solicit succour against his rivals. This Orodes was willing to grant, upon condition that Syria should be delivered up to him; but as Pompey would not consent to such a proposal, the succours were not only denied, but, after the battle of Pharsalia, Orodes put in irons Lucius Hirtius, whom Pompey had again sent to ask assistance, or at least to desire leave to shelter himself in the Parthian dominions.

Cæsar is said to have meditated a war against the Parthians, which, in all probability, would have proved fatal to them. His death delivered them from this danger. But, not long afterwards, the eastern provinces, being grievously oppressed by Marc Antony, rose in arms, and, having killed the tax-gatherers, invited the Parthians to join them in driving out the Romans. The latter readily accepted the invitation, and crossed the Euphrates with a powerful army under the command of Pacorus, and Labienus a Roman general of Pompey's party. At first they met with great success, and overran all Asia Minor, reducing the countries as far as the Hellespont and the Ægean Sea, and likewise subduing Phœnicia, Syria, and even Judea. They did not however long enjoy their new conquests. For, being elated with their victories, and despising the enemy, they engaged Ventidius, Antony's lieutenant, before Labienus had time to join them, and sustained a complete defeat. This so disheartened the army of Labienus, that they all abandoned him; and he himself, being thus obliged to wander from place to place in disguise, was at last taken and put to death at Cyprus. Ventidius, pursuing his advantage, gained several other victories; and at last entirely defeated the Parthian army under Pacorus, cutting almost the whole of them in pieces, and the prince himself amongst the rest. He did not, however, pursue this victory as he might have done, being afraid of giving umbrage to Antony, who had already become jealous of the great honour gained by his lieutenant. He therefore contented himself with reducing those places in Syria and Phœnicia which the Parthians had taken in the beginning of the war, until Antony arrived to take the command of the army upon himself.

Orodes was almost distracted with grief on receiving the dreadful news of the loss of his army, and the death of his favourite son. However, when time had restored the use of his faculties, he appointed Phrahates, the eldest but the most wicked of all his children, to succeed him in the kingdom, admitting him at the same time to a share of the sovereign authority. The consequence of this was, that Phrahates very soon attempted to poison his father with hemlock; but this, contrary to expectation, proving a cure for the dropsy, which an excess of grief had brought upon the king, the unnatural son caused him to be stifled in bed; and soon afterwards not only murdered all his own brothers, thirty in number, but also cut off the rest of the royal family, not sparing even his own eldest son, lest the discontented Parthians should place him, as he was already of age, upon the throne.

Many of the chief lords of Parthia, intimidated by the cruelty of Phrahates, retired into foreign countries. Amongst these was Monœses, a person of great distinction, as well as of skill and experience in war. This man, having fled to Antony, soon gained his confidence, and was by him easily prevailed upon to engage in a war against his countrymen. But Phrahates, justly dreading the consequences of the defection of such a person, sent a solemn embassy to invite him home upon such terms as he should think fit to accept; an offer which greatly provoked Antony, though he did not prevent him from returning, lest others should thereby be discouraged from coming over to him. He therefore dismissed him with great civility, sending ambassadors at the same time to Phrahates to treat of a peace. Thus he hoped to divert the attention of the Parthian monarch from making the necessary preparations for war, and that he should be able to fall upon the despot in the spring, when he was in no condition to offer resistance. But in this he was greatly disappointed; for on his arrival at the Euphrates, which he intended to pass, in order to enter the Parthian dominions on that side, he found all the defiles so well guarded, that he found it expedient to enter Media, with a design first to reduce that country, and then to penetrate into Parthia.

This plan had been suggested to him by Artabazus, king of Armenia, who in the end betrayed him; for instead of conducting the army the straight way from Zeugma on the Euphrates, to the Araxes, which separated Media from Armenia, and which was about five hundred miles distant from the place whence he first set out, Artabazus led him over the rocks and mountains, so that the army had marched above a thousand miles before they had reached the borders of Media, where they intended to begin the war. Thus they were not only greatly fatigued, but had not sufficient time, the year being far spent, to carry into effect the design which they had come to put in execution. However, as Antony was impatient to get back to Cleopatra, he left behind him most of the baggage of the army, and three hundred waggons loaded with battering rams and other military engines for sieges; appointing Statianus, one of his lieutenants, with a body of ten thousand men, to guard them, and to bring them, by slow marches, after the army. With the rest of the forces he marched more than three hundred miles, without allowing his men any respite till he arrived at Praaspa or Phrahata, the capital of Media, which he immediately invested. But the Parthians, well knowing that he could not make any progress without his military machines, passed by his army, in order to attack Statianus; which they did with so much success, that the body commanded by him were to a man cut off, and all their military engines taken, amongst which was a battering ram eighty feet in length.

Notwithstanding this disaster, Antony continued the siege of Praaspa; but was daily harassed by sallies of the garrison from within, and by the enemy's army without. At last, finding it impossible to make himself master of the city, he began to think of a retreat, when his provisions were almost exhausted. But as he had to march three hundred miles through the enemy's country, he thought proper first to send ambassadors to the Parthian monarch, acquainting him that the Roman people were willing to allow him a peace, provided he would restore the standards and prisoners taken at Carrhæ. Phrahates received the ambassadors sitting upon a golden throne; and, after having bitterly inveighed against the avarice and unbounded ambition of the Romans, told them that he would not part with the standards and the prisoners, but that if Antony would immediately raise the siege of Praaspa, he would suffer him to retire unmolested.

Antony, who was reduced to great straits, no sooner received this answer than he broke up the siege, and marched towards Armenia. However, Phrahates was not so good as his word; for the Romans were attacked on their march by the enemy no fewer than eighteen times, and were thrice in the utmost danger of being cut off. As a famine also raged in the Roman army, they began to desert to the enemy; and indeed Antony would probably have been left alone, had not the Parthians, in a very cruel as well as impolitic manner, murdered all those who fled to them, in sight of the rest. At last, after having lost thirty-two thousand men, and being reduced to such despair that he was with difficulty prevented from laying violent hands on himself, he reached the river Araxes; when his men, finding themselves out of the reach of the enemy, fell down on the ground, and kissed it with tears of joy.

Antony was no sooner gone than the kings of Media and Parthia quarrelled about the booty which they had taken; and, after various contests, Phrahates reduced all Media and Armenia. Elated with his conquests, he then oppressed his subjects in such a cruel and tyrannical manner that a civil war broke out, in which the competitors were alternately driven out and restored, until the middle of the first century, when one Vologeses, the son of Gortarzes, a former king, became peaceable possessor of the throne. He carried on some wars against the Romans, but with indifferent success, and at last gladly consented to a renewal of the ancient treaties with that powerful people.

From this time the Parthian history presents nothing remarkable until the reign of the Emperor Trajan, when the Parthian king, by name Cosdroes, infringed the treaty with Rome, by driving out the king of Armenia. Upon this Trajan, glad of any pretence to quarrel with the Parthians, immediately hastened into Armenia. His arrival there was so unexpected that he reduced almost the whole country without opposition, and took prisoner Parthamasiris, the king, who had been set up by the Parthians. After this he entered Mesopotamia, took the city of Nisibis, and reduced to a Roman province the whole of that wealthy country.

Early in the spring of the following year, Trajan, who had withdrawn to winter quarters in Syria, again took the field, but was warmly opposed by Cosdroes. The Roman emperor found him encamped on the banks of the Euphrates, with the design of disputing his passage, which in fact he did with so much vigour, that Trajan, after having several times attempted to ford the river, and been always repulsed, was obliged to cause boats to be built on the neighbouring mountains, which he privately conveyed thence on carriages to the water, and having in the night-time formed a bridge with them, his army passed the next day, though not without great loss and danger, the Parthians harassing his men all the time with incessant showers of arrows. Having gained the opposite bank, he advanced boldly into Assyria, the Parthians flying everywhere before him, and made himself master of Arbela; and thence he pursued his march, subduing, with incredible rapidity, countries where the Roman standard had never before been displayed. Babylonia voluntarily submitted to him, and Babylon itself was, after a vigorous resistance, taken by storm; so that he became master of all Chaldæa and Assyria, the two richest provinces of the Parthian empire. From Babylon he marched to Ctesiphon, the metropolis of the Parthian monarchy, which he besieged, and at last reduced. But whilst Trajan was thus making war in the heart of the enemy's country, Cosdroes, having recruited his army, marched into Mesopotamia, with the design of recovering that country, and cutting off all communication between the Roman army and Syria. On his arrival in that province the inhabitants flocked to him from all parts; and most of the cities, having driven out the garrisons left by Trajan, opened their gates to him. The emperor, however, detached Lucius and Maximus into Mesopotamia to keep in awe such cities as had not revolted, and to open a communication with Syria. Maximus was met by Cosdroes, and having ventured a battle, his army was entirely defeated, and himself killed. But Lucius being joined by Euricius and Clarius, two other commanders sent by Trajan with fresh supplies, gained considerable advantages over the enemy, and retook the cities of Nisibis and Seleucia, which had revolted.

Trajan, seeing himself thus possessed of all the best and most fruitful provinces of the Parthian empire, but at the same time being well aware that he could not, without vast expense, maintain his conquests, or keep in subjection so fierce and warlike a people, at so great a distance from Italy, resolved to place over them a king of his own choice, who should hold the crown of him and his successors, and acknowledge them as his lords and sovereigns. With this view he repaired to Ctesiphon, and having there assembled the chief men of the nation, he crowned one of the royal family, by name Parthanaspates, king of Parthia, obliging all those who were present to engage to pay him allegiance. Thus the Parthians were at last subdued, and their kingdom made tributary to Rome. But they did not long continue in this state of subjection. For no sooner had they heard of Trajan's death, which happened shortly afterwards, than they drove Parthanaspates from the throne, and, recalling Cosdroes, openly revolted against Rome. Hadrian, who was then commander-in-chief of all the forces in the East, and soon afterwards acknowledged as emperor by the army, did not wish, although he was at that time in Syria with a very numerous army, to engage in any new war with the Parthians; but contented himself with preserving the ancient limits of the empire, without any ambitious prospects of further conquests. He therefore abandoned those provinces beyond the Euphrates which Trajan had conquered, withdrew the Roman garrisons from Mesopotamia, and fixed the Euphrates as the boundary of the empire in those parts, posting his legions along the banks of that river.

Cosdroes died after a long reign, and was succeeded by his eldest son Vologeses. In the reign of the latter, the Alani, having broken into Media, which was then subject to the Parthians, committed great devastations, but were prevailed upon, with rich presents sent them by Vologeses, to abandon that kingdom, and return home. Upon their retreat, Vologeses, having no enemy to contend with at home, fell unexpectedly upon Armenia, surprised the legions, and, having cut them in pieces, entered Syria, defeated Attilius Cornelianus, governor of that province, and advanced without opposition to the neighbourhood of Antioch, putting everywhere the Romans, and those who favoured them, to the sword. The Emperor Verus, by the advice of his colleague Antoninus, surnamed the *Philosopher*, having left Rome, hastened into Syria; and having driven the Parthians out of that province, ordered Statius Priscus to invade Armenia, and Cassius to enter the Parthian territories, and carry the war into the enemy's country. Priscus made himself master of Artaxata, and in one campaign drove the Parthians out of Armenia. Cassius, on the other hand, having in several encounters defeated Vologeses, reduced in four years all those provinces which had formerly submitted to Trajan; took Seleucia, and burned and plundered the cities of Babylon and Ctesiphon, with the stately palaces of the Parthian monarchs; and struck terror into the most remote provinces of that empire.

However, Verus, who had never stirred from Antioch and Daphne during the whole time of the war, took upon him the lofty titles of *Parthicus* and *Armenicus*, as if he had acquired them in the midst of his pleasures and debaucheries. After the revolt and death of Cassius, Antoninus the Philosopher repaired to Syria to settle the affairs of that province. On his arrival he was met by ambassadors from Vologeses, who having recovered most of the provinces subdued by Cassius, and being unwilling either to part with them or to engage in a new war, solicited the emperor to confirm him in the possession of them; promising to hold them of him, and to acknowledge the sovereignty of Rome. To these terms Antoninus readily agreed, and a peace was accordingly concluded between the two empires.

Upon the death of Vologeses, the son of his brother Sanatruces, and grandson of Cosdroes, who bore the same name, was raised to the throne. He sided with Niger against the Emperor Severus, who, having settled matters at home, marched with all his forces against him; and advancing to the city of Ctesiphon, whither he had retired, laid close siege to that metropolis. Vologeses made a gallant defence, but the city was at length taken by assault. The king's treasures, with his wives and children, fell into the emperor's hands; but Vologeses himself had the good luck to make his escape. Severus, however, had no sooner crossed the Euphrates than Vologeses recovered all the provinces which he had reduced, except Mesopotamia. These expeditions cost the Romans a great amount of blood and treasure, without yielding any advantages in return. Vologeses was soon afterwards engaged in a war still more troublesome and destructive, with his brother Artabanus, who, encouraged by some of the discontented nobles, attempted to rob him of the crown, and to place it on his own head. Vologeses gained several victories over his rebellious subjects, but died before he could restore the empire to its former tranquillity.

Artabanus, who had a numerous army at his devotion, did not now meet with any opposition in seizing the vacant throne, although Tiridates had a better title to it, as being his elder brother. He had scarcely settled the affairs of his kingdom, when the Emperor Caracalla, desirous to signalize himself, as several of his predecessors had done, by some memorable exploit against the Parthians, sent a solemn embassy to their king, desiring his daughter in marriage. Artabanus, overjoyed at this proposal, received the ambassadors with all possible marks of honour, and readily complied with their request. Soon afterwards Caracalla sent a second embassy to acquaint the king that he was coming to solemnize the nuptials; upon which Artabanus went to meet him, attended with his principal nobility and his best troops, all unarmed. But this peaceable train no sooner approached the Roman army, than the soldiers, on a signal given them, fell upon the king's retinue, and made a most terrible slaughter of the unarmed multitude, Artabanus himself escaping with very great difficulty. Caracalla having by this abominable treachery gained great booty, and, as he thought, no less glory, wrote a long boastful letter to the senate, assuming the title of *Parthicus*, as he had before done that of *Germanicus*, for murdering, in a similar manner, some of the German nobility.

Artabanus having resolved to make the Romans pay dear for their inhuman and barbarous treachery, raised the most numerous army that had ever been known in Parthia, crossed the Euphrates, and entered Syria, which he ravaged with fire and sword. But Caracalla being murdered before this invasion, Macrinus, who had succeeded him, met the Parthians at the head of a mighty army, composed of many legions, and all the auxiliaries of the states of Asia. The two armies no sooner came in sight of each other than they engaged with the utmost fury. The battle lasted two days, both Romans and Parthians fighting so obstinately, that night only parted them, without any apparent advantage on either side. The field of battle was covered with dead bodies; about forty thousand, including both Romans and Parthians, having fallen in the conflict. Nevertheless Artabanus was heard to say that the battle was only begun, and that he would continue it till either the Parthians or Romans were cut in pieces to a man. But Macrinus, being apprised that the king came highly enraged against Caracalla, and dreading the consequences which would attend the destruction of his army, sent a herald to Artabanus, acquainting him with the death of Caracalla, and proposing an alliance between the two empires. The king, understanding that his great enemy was dead, readily embraced the proposal, upon condition that all the prisoners who had been so perfidiously taken by Caracalla should be immediately restored, and a large sum of money paid to defray the expenses of the war.

As Artabanus on this occasion had lost the flower of his army, Artaxerxes, a Persian of mean descent, but of great courage and experience in war, revolted against the Parthians, and, having prevailed on his countrymen to join him, attempted to recover the sovereign power, which, he said, they had been unjustly deprived of, first by the Macedonians, and afterwards by the Parthians their vassals. Upon the news of this revolt, Artabanus marched with the whole strength of his kingdom to suppress it; but being met by Artaxerxes at the head of an army no less powerful, a bloody battle ensued, which is said to have lasted three days. At length the Parthians, though they behaved with the utmost bravery, and fought like men in despair, were forced to yield to the Persians, who were commanded by a more experienced leader. Most of their troops were cut off in the flight; and the king himself having been taken prisoner, was soon afterwards put to death by order of Artaxerxes. In this fatal engagement, the Parthians having lost both their king and their army, were forced to submit to the conqueror, and become the vassals of a nation which had been subject to them for the space of four hundred and seventy-five years.

PARTI, Partie, *Party*, or *Parted*, in *Heraldry*, is applied to a shield or escutcheon, denoting that it is divided or marked out into partitions.

PARTICIPLE, in *Grammar*, an adjective formed of a verb, and so called because it participates partly of the properties of an adnoun and partly of those of a verb. See the article Grammar.

PARTICLE, in *Grammar*, a denomination for all those small words which connect or unite others, or express the modes or manners of words.

PARTISAN, in war, a person dexterous in commanding a party, and who, knowing the country well, is employed in getting intelligence, or surprising the enemy's convoys and posts. The word also means an officer sent out upon a party, with the command of a body of light troops, generally under the appellation of the partisan corps.

PARTNERSHIP, is a contract amongst two or more persons, to carry on a certain business, at their joint risk and expense, and to share the gain or loss arising from it.

PARTRIDGE, a species of bird. See Ornithology.

Partridge's *Island*, on the south coast of Van Diemen's Land, was so called by Entrecasteaux, the French navigator. Lat. 43. 23. S.

PARTY, in a military sense, a small number of men, horse or foot, sent upon any kind of duty, as into an enemy's country to pillage, to take prisoners, and to levy contributions. Parties are often sent out to examine the roads and ways, procure intelligence, forage, reconnoitre, or amuse the enemy upon a march; and they are also frequently sent upon the flanks of an army or regiment, to discover the enemy if near, and prevent surprise or ambuscade.

PARUPANADA, a town of Southern India, situated on the sea-coast of the province of Malabar. The small town of Vuypura was originally called the North Parupanada. It is pleasantly situated on the northern bank of a river, near the sea-coast, and which would be navigable for ships were it not for a large bar at its mouth. The other town of Parupanada contains 700 houses, mostly built of stone, and is well aired; and the surf, compared with that which breaks on the Madras shore, is trifling; so that, excepting in some places where rocky head-lands run into the sea, boats of any kind may without any danger land on the coast. From two to three thousand teak trees may be procured here annually. It is twenty-two miles south from Calicut. Long. 75. 55. E. Lat. 11. 2. N.

PARVICH, an island near Dalmatia, containing many

Roman antiquities, which evidently show that it was a Roman station. It seems to have been amongst the number of those islands which Pliny calls *Celadussæ*, supposed to be an inversion of δοσκελαδος, meaning *ill sounding* or *noisy*. Parvich is not of large extent, but is extremely fertile. Every product attains perfection there, particularly those which require a very shallow soil, such as wine, oil, mulberry trees, and fruit. The aspect of this island is also very pleasant at a distance, but that of the others adjacent shocks the eye by their high, rocky, and naked hills. The name of *Parvich* seems to have been given it because it is the first one observed on going out of the harbour of Sibenico; the Illyrian word *parvi* signifying *first*.

PASANGA, a small island in the Eastern Seas, near the western coast of Sumatra. Lat. 5. 10. S.

PASAY, a town of Sumatra, situated in a fine bay on the northern extremity of the island, abounding in cattle, provisions, and grain, and also in fine timber.

PASCAL, Blaise, one of the greatest geniuses and best writers that France has produced, was born at Clermont, in Auvergne, in the year 1623. His father, Stephen Pascal, born in 1588, and descended of an ancient family, was president of the court of aids in his province; and being a very learned man, and an able mathematician, he was a friend of Descartes. Having an extraordinary tenderness for this child, who was his only son, he quitted his office, and settled at Paris in 1631, that he might be at leisure to attend to his instruction; and young Pascal never had any master but his father. From his infancy he gave proofs of extraordinary capacity; for he desired to know the reason of every thing, and when good reasons were not given him, he would seek for better, refusing to yield his assent except upon such as appeared to him to be well grounded. It was feared that, with such a turn of mind, he might fall into free-thinking, or at least into heterodoxy; but this apprehension proved groundless.

What is told of his manner of learning the mathematics, as well as of the rapid progress which he made in that science, seems almost miraculous. His father, perceiving in him an extraordinary inclination to reasoning, was afraid lest the knowledge of the mathematics might prevent his acquiring the languages. He therefore kept him as much as he could from all notions of geometry, locked up all his books on that subject, and even refrained from speaking of it in his presence. He could not, however, prevent his son from musing upon geometrical propositions, and one day surprised him at work with some charcoal upon his chamber floor, and in the midst of figures. Having asked the boy what he was doing, he received for answer, I am searching for such a property, which was in fact that demonstrated in the thirty-second proposition of the first book of Euclid. His father then asked him how he came to think of this? It was, says Pascal, because I had found out such another thing; and so going backwards and using the names of *bar* and *round*, he came at length to the definitions and axioms which he had formed to himself. Does it not seem almost miraculous that a boy should work his way into the heart of a mathematical work, without ever having seen that or any other book upon the subject, or knowing any thing of the terms? Yet we are assured of the truth of this by Madame Perrier, and by several other writers, the credit of whose testimony cannot reasonably be questioned. Thenceforward he had full liberty to indulge his genius in mathematical pursuits. He understood Euclid's Elements as soon as he cast his eyes upon them; and this need not seem strange, for, as we have seen, he understood them before.

At sixteen years of age he wrote a treatise on Conic Sections, which was accounted by the learned a mighty effort of genius; and therefore it is not wonderful that Descartes, who had been a long time in Holland, should, upon reading it, have been inclined to believe that M. Pascal the father was the real author of the work. At nineteen he contrived an admirable mathematical machine, which was esteemed a wonderful thing, and would have done credit as an invention almost to any man conversant with science, far less to a mere youth. About this time his health became impaired, and he was in consequence obliged to suspend his labours; nor was he in a condition to resume them till nearly four years afterwards. About that period, having seen Torricelli's experiment respecting a vacuum and the weight of the air, he turned his thoughts towards that subject; and in a conference with M. Petit, intendant of fortifications, proposed to make farther researches. In pursuance of this idea, he undertook several new experiments. In particular, having provided a glass tube, forty-six feet in length, open at one end, and sealed hermetically at the other, he filled it with red wine, that he might distinguish the liquor from the tube. He then elevated the latter in this condition; and having placed it perpendicularly to the horizon, stopped up the bottom, and plunged it into a vessel full of water to the depth of a foot; after which he opened the extremity of the tube, and the wine descended till about thirty-two feet above the surface of the vessel, leaving a considerable vacuum at the upper extremity. He next inclined the tube, and remarked that the wine rose higher; and having inclined it till the top was within thirty-two feet of the ground, making the wine thus run out, he found that the water rose in it, so that it was partly filled with that fluid, and partly with wine. He made also a great many experiments with syphons, syringes, bellows, and all kinds of tubes, employing different liquors, such as quicksilver, water, wine, and oil; and having published an account of his experiments in 1647, he dispersed his work throughout all France, and also transmitted it to foreign countries. All these experiments, however, ascertained effects, without demonstrating the causes. Pascal knew that Torricelli conjectured that those phenomena which he had observed were occasioned by the weight of the air; and, in order to discover the truth of this theory, he made an experiment at the summit and foot of a mountain in Auvergne, called Le Puy-de-Dome, the result of which led him to conclude that air had weight. Of this experiment he also published an account, and sent copies of it to most of the learned men in Europe. He likewise renewed the experiment at the top of several high towers, such as those of Nôtre Dame at Paris, St Jacques de la Boucherie, and some others; and he always remarked the same difference in the weight of the air at different elevations. This fully convinced him of the weight of the atmosphere; and from this discovery he drew many useful and important inferences. He also composed a large treatise, in which he thoroughly explained this subject, and replied to all the objections which had been started against it. As he thought this work rather too prolix, and as he was fond of brevity and precision, he divided it into two small treatises, one of which he entitled a Dissertation on the Equilibrium of Liquors; and the other, an Essay on the Weight of the Atmosphere. These labours procured Pascal so much reputation, that the greatest mathematicians and philosophers of the age proposed various questions to him, and consulted him respecting such difficulties as they could not resolve.

Some years after, whilst tormented with a violent fit of the toothach, he discovered the solution of a problem proposed by Father Mersenne, which had baffled the penetration of all those who had attempted it. This problem was to determine the curve described in the air by the nail of a coach-wheel whilst the machine is in motion. Pascal offered a reward of forty pistoles to any one who should give a satisfactory answer to the question. As no one succeeded, however, he published his own at Paris; but as he now began to be disgusted with the sciences, he did not put his real name to it, and sent it abroad under that of A. d'Ettenville. This was the last work which he published in the mathematics; and his infirmities now increased so much that he was under the necessity of renouncing severe study, and of living so recluse that he scarcely admitted any person to see him.

After he had laboured thus successfully in mathematical and philosophical disquisitions, he forsook these studies and all human learning at once. He was not twenty-four years of age, when the perusal of some pious books had inspired him with this resolution; and he became as great a devotee as any age has produced. He now devoted himself entirely to a state of prayer and mortification. He had always in his thoughts the great maxim of renouncing all pleasures and all superfluity; and this he practised with rigour even in his illnesses, to which he was frequently subject, being of a very feeble habit of body. He had no violent affection for those he loved; and he even thought it sinful, since a man possesses a heart which belongs only to God. He found fault with some discourses of his sister, which she thought very innocent; and subjected himself to severe mortification and abstinence.

But though Pascal had thus abstracted himself from the world, yet he could not forbear paying some attention to what was passing in it; and he even interested himself deeply in the contest between the Jesuits and the Jansenists. The Jesuits, although they had popes and kings on their side, were yet decried by the people, who raked up afresh against them the assassination of Henry IV., and all the old stories which were likely to render them odious. Pascal went farther, and by his *Lettres Provinciales*, published in 1656, under the name of Louis de Montalte, made them the subject of the keenest irony and ridicule. These letters may justly be considered as a model of eloquence and humour. The best comedies of Molière have not more wit than the first part of them; and the sublimity of the latter part is equal to any thing in Bossuet. It is true, indeed, that the whole book was built upon a false foundation; for the extravagant notions of a few Spanish and Flemish Jesuits were artfully ascribed to the whole society. Many absurdities might likewise have been discovered amongst the Dominican and Franciscan casuists; but this would not have answered the purpose; for the whole raillery was to be levelled only at the Jesuits. The Provincial Letters were intended to prove that the Jesuits had formed a design to corrupt mankind; a design which no sect or society ever had or can have. Voltaire considers Pascal as the first of the French satirists; for Despreaux, says he, must be regarded as only the second. In another place, speaking of this work, he says, that examples of all the various species of eloquence are to be found in it. "Though it has been now written almost a hundred years, yet not a single word occurs in it savouring of that vicissitude to which living languages are so subject. Here then we are to fix the epoch when our language may be said to have assumed a settled form. The Bishop of Lucon, son of the celebrated Bussy, told me, that asking one day the Bishop of Meaux what work he would covet most to be the author of, supposing his own performances set aside, Bossuet replied, the Provincial Letters." These letters have been translated into all languages, and printed in every possible form. Some have said that there were decrees of formal condemnation against them; and, further, that Pascal himself, in his last illness, detested them, and repented of having been a Jansenist; but neither of these statements seems to rest upon any good authority. Father Daniel wrote an answer to the Provincial Letters, entitled the Dialogues of Cleander and Eudoxus. These celebrated Letters appear to have been the joint productions of Arnauld, Nicole, and Pascal. Nicole and Arnauld supplied the materials, which Pascal worked up into those finished productions that fixed the language in which they were written, and have been admired by every succeeding age, as well as by that in which they were first given to the world.

Pascal was only about the age of thirty when the Provincial Letters were published; yet he was extremely infirm, and soon afterwards his disorders increased so much that, conceiving his end to be fast approaching, he gave up all farther thoughts of literary composition. He resolved to spend the remainder of his days in retirement and religious meditation; and with this view he broke off all his former connections, changed his habitation, and spoke to no one, not even to his own domestics. He made his own bed, fetched his dinner from the kitchen, carried it to his apartment, and brought back the plates and dishes in the evening; so that he employed his servants only to cook for him, to go to town, and to do such other offices as he could not conveniently perform himself. In his chamber nothing was to be seen but two or three chairs, a table, a bed, and a few books. It had no kind of ornament whatever; he had neither a carpet on the floor nor curtains to his bed: But this did not prevent him from sometimes receiving visits; and when his friends appeared surprised to find him thus without furniture, he replied, that he had what was necessary, and that anything else would be a superfluity, unworthy of a wise man. He employed his time in prayer, and in reading the Holy Scriptures; and he wrote down such thoughts as this exercise inspired. Though his continual infirmities obliged him to use very delicate food, and his servants employed the utmost care in providing only what was excellent, he never relished what he ate, and seemed quite indifferent whether what they brought him was good or bad.

But although he had now abandoned intense study, and lived in the most temperate manner, his health continued to decline rapidly; and his disorders had so enfeebled his organs, that his reason became in some measure affected. He always imagined that he saw a deep abyss on his left side; and he never would sit down till a chair was so placed as to secure him from the fancied danger which he apprehended. His friends did everything in their power to banish this melancholy idea from his thoughts, and to cure him of his error, but without effect. Though he would become calm and composed for a little, yet the phantom would in a few moments return again and torment him with this painful delusion. The cause of his seeing this singular vision for the first time is said to have been the following. His physicians, alarmed on account of the exhausted state to which he was reduced, had advised him to substitute easy and agreeable exercise for the exhausting labours of the closet. One day, in the month of October 1654, having gone, according to custom, to take an airing on the Pont de Neuilly, in a coach and four, the two leading horses suddenly took fright opposite to a place where there was no parapet, and threw themselves violently into the Seine; but the traces having luckily given way, the carriage remained on the brink of the precipice. The shock which Pascal, in his languishing situation, must have received from this dreadful accident, may easily be imagined. It threw him into a fit, which continued for some time, and it was with great difficulty that he could be restored to his senses. After this period his brain became so disordered that he was continually haunted by the remembrance of his danger, especially when his infirmities prevented him from enjoying sleep. During the last years of his life, in which he exhibited a melancholy example of the humiliating changes which take place in this transitory world, and which, if properly considered, might teach mankind not to be too proud of those abilities, however splendid, which a moment may take from them, he attended all the stated prayers, visited every church in which relics were exposed, and had always a spiritual almanack, containing an account of all those places where particular acts of devotion were performed. On this occasion it has been said that religion renders great minds capable of little things, and little minds capable of great things.

In company Pascal was distinguished by his amiable behaviour, his easy, agreeable, and instructive conversation, and his great modesty. He possessed a natural kind of eloquence, which was in a manner irresistible; and no one ever had the happiness of meeting him, without being at once instructed and delighted. His divine humility showed itself in all things, attempered with a grace and simplicity which imparted to it an indescribable charm. Towards the close of his life he employed himself wholly in pious and moral reflections, writing down those which he judged worthy of being preserved. The first piece of paper that he could find was employed for this purpose; and he commonly put down only a few words of each sentence, as he wrote them merely for his own use. The bits of paper upon which he had written these thoughts were found after his death filed upon different pieces of string, without any order or connection; but being copied exactly as they were written, they were afterwards arranged and published. He died at Paris on the 19th of August 1662, aged thirty-nine years.

The works of Pascal were collected in five volumes octavo, and published at the Hague by De Tune, and at Paris by Nyon, in 1779. This edition of Pascal's works may be considered as the first published; at least the greater part of them were not before collected into one body, and some of them had still remained in manuscript. For this collection the public were indebted to the Abbé Bossu, and Pascal deserved to have such an editor. See remarks on his philosophical character in the *First Dissertation*, prefixed to this work.

PASCO, a province of Peru, in the department of Junin, and celebrated for its mines of silver and gold, particularly the former. This district is situated at a prodigious elevation, some parts of it being more than 14,000 feet above the level of the sea, and is consequently much colder than its latitude would indicate, which is only about eleven degrees south of the equator. The following notice of Pasco is from an article in the Journal of the Geographical Society, giving an account of the recent travels of Dr Poeppig in this country: "He then entered the plain of Bonbon, in which the rich silver mines of Pasco are situated, and which extends upwards of six leagues in width from east to west. The greatest part of the waters collected on this plain run to the lake Lauricocha, the source of the Amazon. The Cerro de Pasco, in whose neighbourhood the richer mines are situated, is an irregularly built place, with about 7000 inhabitants (Lieutenant Smyth, in 1834, says from 12,000 to 16,000 inhabitants), and stated at 14,280 feet above the sea. From the Cerro de Pasco the author gradually descended in a northerly direction, by the eastern declivity of the Andes, to a valley traversed by the upper branch of the Huallaga, called Huanuco. At Coxamarquilla, a village more than three leagues from the Cerro, the ground had already so much lowered, that he found there plantations of vegetables. Trees made their appearance lower down; and at San Rafael he saw the first fields of wheat, which ascends in the valleys of the Andes to an elevation of 9000 feet. Before reaching the town of Huanuco, the level part of the valley was covered with sugar-cane plantations, and even the less steep declivities of the mountains on both sides were cultivated. Dr Poeppig followed the course of the Huanuco or Huallaga, from its source to its mouth. This river, which traverses more than five degrees of latitude, rises in the plain of Bonbon, in the Laguna de Chiquiacoba, not far from the Cerro, at an elevation of 13,200 feet above the sea. This alpine lake is only separated by a low ridge of hills from the Laguna de Quiluacocha, from which the Rio Mantaro, one of the principal branches of the Apurimac, issues under the name of Rio de San Juan. The Rio Huanuco runs first north as far as the town of Huanuco, then east about fifty miles with great violence through a rather narrow vale, and then it turns suddenly to the north-north-west and north, which course it pursues to its junction with the Amazon." Before the revolution the mines of Pasco yielded annually 131,000 lbs. troy of silver. During that convulsion the costly machinery was destroyed, and the water was allowed to take full possession of the mines. Both loyalists and patriots repeatedly plundered the stores, and for a long time operations were nearly suspended. This province is noted only for its mines. It is divided into three districts, each of which has its church and priest; but, in spite of the efforts of the latter, the miners belonging to the different districts live in a state of almost perpetual hostility with each other. When Lieutenant Smyth visited the mines of Pasco in 1834, the working of them had been resumed with some spirit; but the steam-engines which had been erected by an English company some years before were found either destroyed, or so much injured as to be unfit for use. These mines were discovered in the year 1630, by Huari Capac, an Indian.

PASIGRAPHY (from πας, *omnis*, and γραφω, *scribo*), the art of writing on any subject whatsoever, so as to be universally understood by all nations of the earth. The idea of establishing such a language is deemed by many extremely fanciful and absurd, whilst the practicability of it is as strenuously contended for by others. Hints respecting such a system of writing as might be understood by all mankind are to be met with in the writings of many eminent philosophers; but the attempt has signally failed, even in the hands of a Leibnitz, a Kircher, a Becher, and a Wilkins. Kant is clearly of opinion, however, that such a pasigraphy falls within the limits of possibility; nay, he even prognosticates that it will certainly be established at some future period.

PASIHAN, one of the smaller Philippine Islands, near the west coast of Leyta. Long. 124. 12. E. Lat. 10. 35. N.

PASIPHAE, in fabulous history, a daughter of the Sun by Perseis, and who married Minos, king of Crete. She disgraced herself by an unnatural passion for a bull, which we are told she was enabled to gratify by a contrivance of the artist Dædalus. This celebrated bull had been given to Minos by Neptune to be offered on his altars. But as the monarch refused to sacrifice the animal on account of his beauty, the god revenged his disobedience by inspiring Pasiphaë with an unnatural love for him. This fable, which is universally believed by the poets, is discarded by some writers, who suppose that the infidelity of Pasiphaë to her husband was betrayed in her affection for an officer of the name of Taurus, and that Dædalus, by permitting his house to be the place of assignation between the two lovers, was looked upon as accessory to the gratification of Pasiphaë's passion. From this amour with Taurus, as is farther remarked, the queen became mother of twins; and the name of *Minotaurus* arose from the resemblance of the children to the husband and the lover of Pasiphaë. Minos had by Pasiphaë four sons, Castreus, Deucalion, Glaucus, and Androgeus; and three daughters, Hecate, Ariadne, and Phædra.

PASQUIN, a mutilated statue at Rome, in a corner of the palace of the Ursini. It takes its name from a cobbler of that city, called *Pasquin*, famous for his sneers and gibes, and who diverted himself by cracking his jokes upon all who passed through that street. After the death of the cobbler, as some persons were digging up the pavement before his door, they found in the earth the statue of an ancient gladiator, well cut, but maimed and half spoiled; and having set up this in the place where it was found, they by common consent named it *Pasquin*. Since that time all satires are attributed to the figure in question, and are either put into its mouth, or pasted upon it, as if they were written by Pasquin himself. They are addressed by Pasquin to Marforio, another statue at Rome. When Marforio is attacked, Pasquin comes to his assistance; and when Pasquin is attacked, Marforio defends him in his turn; in other words, the people make the statues say just what they please.

PASQUINADE, a satirical libel fastened on the statue of Pasquin. Such productions are commonly short, witty, and pointed; and hence the term has been applied to all lampoons of this description.

PASS, or Passade, in fencing, an advance or leap forward upon the enemy. Of these there are several kinds, as passes within, above, beneath, to the right, to the left, and passes under the line. The measure of the pass is when the swords are so near that they may touch one another. See Fencing.

PASSADE, in the manège, is a turn or course of a horse backwards or forwards on the same spot of ground. Hence there are several sorts of passades, according to the different ways of turning, in order to part or return upon the same tread, which is called *closing the passade;* as the passade of one time, the passade of five times, and the raised or high passades.

PASSAGE Island, a small island amongst the Philippines, about twenty miles east from the island of Leyta. Long. 125. 27. E. Lat. 10. 44. N.

Passage *Isle*, a small island on the northern coast of Sumatra, which here forms a deep bay, where there are several Malay ports. Long. 97. 55. E. Lat. 2. 31. N.

PASSAGES, a seaport town of the province of Guipuscoa, in Spain. It stands on both banks of the river Oyarzun, near to the place where it falls into the Bay of Biscay, and having its entrance defended by the castle of St Isabel. The harbour was formerly adapted to admit the largest ships, but it is now so injured by the sand accumulated at its mouth, as to be accessible only to vessels of light draught of water. It still has a naval arsenal and hospital, and capacious storehouses, though but little use is made of them. It has two churches, a chapel, and an hospital, with 520 houses, and 2400 inhabitants, many of whom find employment in the fisheries. Long. 2. 0. 5. W. Lat. 43. 20. 30. N.

PASSAMAN, a small province of Sumatra, being one of the most northerly, and situated immediately under the equinoctial line. It was formerly subject to the dominion of Menancabow, but is now subject to the Achinese. It is divided into a number of petty kingdoms, each of which is governed by a rajah, and was formerly a place of considerable trade. Besides exporting large quantities of pepper, it received much fine gold from the mountains that are situated about three days' journey inland.

PASSANT, in *Heraldry*, a term applied to a lion or other animal in a shield, which appears to walk leisurely. For most beasts, except lions, the term *trippant* is frequently used instead of that of *passant.*

PASSAROUANG, a small town and fort on the northern shore of the island of Java. It is the capital of a large principality, and is intersected by a large river, over which there is a wooden bridge. It is pleasantly situated, has a healthy climate, and its native population is numerous. The surrounding country is fertile, and produces abundant crops of rice and maize. The roads are good; posts have been established along the coast; and it appears to be in all respects a busy and well-regulated settlement. It is situated in longitude 113. 10. east, and latitude 7. 3. south.

PASSAU, a city of the kingdom of Bavaria, in the circle of the Lower Danube, being the capital of the circle, as well as that of the bailiwick, of the same name. It is situated on a peninsula, formed by the junction of the river Inn with the Danube. It is strongly fortified, and farther defended by a citadel and the castle of Oberhaus. There are handsome bridges over both the Danube and the Inn. It is the see of a bishop, who has a palace and a cathedral, and it contains 822 houses, with 10,350 inhabitants. Notwithstanding its very advantageous situation on two navigable rivers, it enjoys very little trade, and has only some small manufactures. Long. 12. 54. E. Lat. 48. 35. N.

PASSION is a word of which, as Dr Reid observes, the meaning is not precisely ascertained either in common discourse or in the writings of philosophers. In its original import, it denotes every *feeling* of the mind occasioned by an extrinsic cause; but it is generally used to signify some *agitation* of mind, opposed to that state of tranquillity in which a man is most master of himself. That it was thus used by the Greeks and Romans, is evident from Cicero's rendering παθος, the word by which the philosophers of Greece expressed it, by *perturbatio* in Latin. In this sense of the word, passion cannot be itself a distinct and independent principle of action, but only an occasional degree of vehemence given to those dispositions, desires, and affections, which are at all times present to the mind of man; and that this is its proper sense, we require no other proof than that passion has always been conceived to bear an analogy to a storm at sea or to a tempest in the air. See Moral Philosophy.

Passion-Week, the week immediately preceding the festival of Easter, and so called because in that week happened our Saviour's passion and death. The Thursday of this week is called Maunday Thursday; the Friday, Good Friday; and the Saturday, the Great Sabbath.

PASSIR, a town and district of Borneo, pleasantly situated on a river of the same name, about fifty miles from its mouth, near the bottom of a large bay, on the eastern side of the island. The river is joined by five other tributary streams, and is very rapid near the town, above which the tide ascends, rising to the height of several feet. The town consists of three hundred wooden houses, situated on the northern side of the river, most of them inhabited by Buggess merchants. This was formerly a place of considerable trade. In the year 1772 the East India Company attempted to establish a factory here for the sale of opium, piece-goods, &c.; but the plan was frustrated by a commotion amongst the natives, at which the English commander took an alarm, and quitted the country. Passir has since this period been seldom visited by Europeans; more especially since several vessels have been cut off by the numerous pirates who frequent the coast and the neighbouring islands. The Chinese who have settled here are remarkably industrious, and are in possession of the principal trade. The surrounding country is fertile, and yields in great abundance rice, besides benzoin, aloes, pepper, cassia, and long nutmegs; also various kinds of fruit, excellent mastic and other gums, particularly dragon's blood; honey, gold dust, and camphor. The imports are nearly similar to those of the other Malay ports, namely, opium, fire-arms, gunpowder, lead, iron, and steel, cutlery, swords, cloths, chintzes, looking-glasses, &c. The inhabitants do not bear a good character. They are fraudulent and treacherous, and have cut off many ships in the most treacherous manner. They are also unjust in their weights and measures, and are expert in the practice of various other frauds. The country is flat and unhealthy, being covered with thick woods, and annually overflowed. The exhalations from this moisture, and the thick fogs, are extremely insalubrious. The thick fogs turn to rain, and are accompanied by chilling winds. The great numbers of frogs and vermin which are generated by the heat, and afterwards destroyed, occasion an intolerable stench, and add to the unhealthiness of the place. Long. of the town 116. 10. E. Lat. 1. 57. N.

PASSIVE, in general, denotes something that suffers the action of another, which is called an agent or active power. In grammar, the verb or word which expresses this passion is termed a *passive verb*, and, in the learned languages, has a peculiar termination; as, *amor*, *doceor*, *legor*, in Latin, that is, an *r* is added to the actives, *amo*, *doceo*, *lego;* and, in

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the Greek, the inflection is made by changing ω into ομαι, as τυπτω, τυπτομαι, and πειθω, πειθομαι. But in the modern languages the passive inflection is effected by means of auxiliary verbs, joined to the participle of the past tense; as, *I am praised*, in Latin *laudor*, and in Greek ἐπαινεομαι; or, *I am loved*, in Latin *amor*, and in Greek φιλεομαι. Thus it appears that the auxiliary verb *am* serves to form the passives of English verbs: and the same thing holds of the French, as *Je suis loué*, I am praised; *j'ai été loué*, I have been praised, and so forth. See the article GRAMMAR.

PASSIVE Obedience, a political doctrine, very obnoxious to the friends of freedom. Some nonjurors, imagining that monarchy is the only lawful form of government, and that hereditary monarchy is the only lawful species of that government, have coupled with passive obedience the ridiculous notion of a divine, hereditary, indefeasible right in certain families to govern with despotic sway all other families of the same nation. The absurdity of this notion scarcely needs refutation; but it may not be improper to observe, that it has nothing to do with passive obedience.

This, as taught by the ablest reasoners, who think that they are supported by the Holy Scripture, is as much a duty under republican as under monarchical governments; and it means no more than that private individuals are bound, both by moral and religious ties, not to resist the supreme power, wheresoever it may be placed, in any nation. The supreme power can only be the legislature; and no man or body of men, who have not the power of enacting and abrogating laws, can, upon this principle, claim passive obedience from any subject. Whether the principle be well or ill founded, the absurdity which commonly attaches to the phrase *passive obedience* originates from the mistaken loyalty of the adherents of the house of Stuart, who, to aggravate the illegality of the Revolution, were accustomed to represent James II. as supreme over both houses of parliament, and of course also over all law. That such reveries were foolish, we need no other evidence than the statute-book, which shows, that in the office of legislation, the King, Lords, and Commons, are co-ordinate; and that when any one of these powers shall take upon itself to counteract the other two, even the duty of passive obedience will oblige the subject to support the legislature. That resistance to the legislature can only be lawful to oppose insupportable tyranny, has been shown by Mr Hume with great cogency of argument. That it can never be lawful on any occasion, Bishop Berkeley has endeavoured to prove by a chain of reasoning, which must, at least, be allowed to display considerable ingenuity and force. On this subject we refer our readers to Hume's Essays, Berkeley's tract on Passive Obedience and Non-resistance, and Locke's Essay on Government.

PASSOVER, a solemn festival of the Jews, instituted in commemoration of their exod from Egypt, because, the night before their departure, the destroying angel, who put to death all the first-born of the Egyptians, passed over the houses of the Hebrews without entering therein, as they were marked with the blood of the lamb which had been killed the evening before, and which, for this reason, was called the *paschal lamb*. This feast was called *pascha* by the Greeks and Romans, not, we presume, from πασχω, *I suffer*, as Chrysostom, Irenæus, and Tertullian suppose, but from the Hebrew word PESAH, signifying *passage*. What God ordained concerning the passover of the Jews is contained in Exodus (c. xii.). The month of the departure from Egypt was looked upon, from this time, as the first month of the sacred or ecclesiastical year; and on the fourteenth day of this month, between the two vespers, that is, between the sun's decline and his setting, or rather, according to our manner of reckoning, between two o'clock in the afternoon and six o'clock in the evening, at the equinox, they were required to kill the paschal lamb, and to abstain from leavened bread. The day following, being the fifteenth, reckoning from six o'clock of the foregoing evening, which concluded the fourteenth day, was the grand feast of the passover, which continued seven days. But it was only the first and the seventh day that were solemn. The lamb killed was to be without any defect, a male, and yeaned that year. If no lamb could be found, they might take a kid. They killed a lamb or a kid in every family; and if the number of those who lived in the house was not sufficient to eat a lamb, two houses might join together. With the blood of the paschal lamb they sprinkled the door-posts and lintels of every house, that the destroying angel, at the sight of the blood, might pass over them, and thus spare the Hebrew children. They were required to eat the lamb the same night that followed the sacrifice. They ate it roasted, with unleavened bread, and a salad of wild lettuce; the Hebrew says literally, with bitter things, as mustard, or any thing of this nature, to give it a relish. It was forbidden to eat any part of it raw, or boiled in water, nor were they to break a bone of the victim;[1] and if any thing remained until the day following, it was thrown into the fire. They who ate of it were to be in the posture of travellers, having their loins girt, their shoes on their feet, their staves in their hands, and eating in a hurry. But this last part of the ceremony was little observed, at least it was of no obligation, excepting only on that night when they went forth out of Egypt. During the whole eight days of the passover no leavened bread was to be used; and whoever should eat any, was threatened with being cut off from his people.

The Jews observed the first and last day of the feast, yet so as that it was allowed to dress victuals, which was forbidden on the Sabbath-day. The obligation of keeping the passover was so strict, that whoever neglected to do it was condemned to death.[2] But those who had any lawful impediment, as a journey, sickness, or any uncleanness, voluntary or involuntary, as, for example, those who had been present at a funeral, or by any other accident had been defiled, were to defer the celebration of the passover till the second month of the ecclesiastical year, or till the fourteenth day of the month Jair, which answers to April and May. It was thus that the Lord ordered Moses, upon the occasion of an inquiry by some Israelites, who had been obliged to pay the last offices to some of their relations, and who being thus polluted, were not capable of partaking of the paschal sacrifice.[3] The modern Jews observe in general the same ceremonies which were practised by their ancestors in the celebration of the passover. Upon the fourteenth of Nisan, the first-born fast in memory of God's smiting the first-born of the Egyptians; but the morning prayers are the same with those which are said on other festivals. They take the roll of the Pentateuch out of the chest, and read as far as the end of the twelfth chapter of Exodus, and also what is contained in the eighteenth chapter of Numbers, relating to the passover. The matron of the family then spreads a table, and sets on it two unleavened cakes, and two pieces of the lamb, a shoulder boiled and another roasted, to put them in mind that God had delivered them with a stretched-out arm. To this they add some small fishes, because of the leviathan; a hard egg, because of the ziz; some meal, because of the behemoth, these three animals being appointed for the feast of the elect in the other life; and pease and nuts for the children, to provoke their curiosity to inquire into the reason of the ceremony. They likewise use a kind of mustard, which has the appearance of mortar, to represent their making bricks in Egypt. The father of the family sits down

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[1] Exodus, vii. 46; Numbers, ix. 12; John, xix. 36.

[2] Numbers, ix. 13.

[3] 2d Chronicles, xxx. 1, 2, &c.

Passport.

along with his children and slaves, because upon this day all are free. Being seated, he takes bitter herbs, and dips them in the mustard, then eats, and distributes to the rest. All then partake of the lamb, the history and institution of which is at the same time recited by the master of the family. The whole repast is attended with hymns and prayers. They pray for the prince under whose dominion they live, according to the advice of Jeremiah (xxix. 7), "Seek the peace of the city whither I have caused you to be carried away captives, and pray unto the Lord for it; for in the peace thereof shall ye have peace." The same things are put in practice during the two following days; and the festival is concluded by the ceremony called *habdala*, or distinction. This ceremony is performed at the close of the Sabbath-day, at which time the master of the house usually pronounces certain benedictions, accompanied with certain formalities, requesting that everything may succeed well the week following. After going out of the synagogue, they eat leavened bread for the last time.[1] Whilst the temple remained, they brought thither their lambs, and there sacrificed them, offering the blood to the priest, who poured it out at the foot of the altar. The passover was typically predictive of Christ, who is the Christian passover.[2] As the destroying angel passed over the houses marked with the blood of the paschal lamb, so the wrath of God passes over those whose souls have been sprinkled with the blood of Christ. The paschal lamb was killed before Israel was delivered; so it was necessary that Christ should suffer before we could be redeemed. It was killed before Moses's law or Aaron's sacrifices were enjoined, to show that deliverance comes to mankind by none of them, but only by the true passover, that Lamb of God slain from the foundation of the world.[3] It was killed the first month of the year, which prefigured that Christ should suffer death in this month.[4] It was killed in the evening;[5] and so Christ suffered in the last days, and at this period of the day.[6] At evening also the sun sets, which shows that it was the Son of righteousness who was to suffer and die, and that at his passion universal darkness should overshadow the earth.[7] The passover was roasted with fire, to denote the sharp and dreadful pains which Christ should suffer, not only from men, but also from God. It was to be eaten with bitter herbs, not only to put them in remembrance of their bitter bondage in Egypt, but also to typify our mortification to sin, and readiness to undergo afflictions for Christ.[8] Many persons erroneously imagine that the passover was instituted in memory of the Israelites having passed the Red Sea; although it is certain the feast was held, and received its name, before the Israelites left Egypt, and consequently several days before they passed the Red Sea. Besides the passover celebrated on the fourteenth of the first month, there was a second passover, held on the fourteenth of the second month after the equinox, instituted by God in favour of travellers and sick persons, who could not attend at the first, nor be present at Jerusalem on the day. The Greeks, and even some of the Catholic doctors, take occasion, from the thirteenth, eighteenth, and nineteenth chapters of St John, to conclude, that Jesus anticipated the day marked for the passover in the law; but the authority of three evangelists seems to establish the contrary.

PASSPORT, or PASS, a license or writing obtained from a prince or governor, granting permission and a safe conduct to pass through his territories without molestation. It is also a permission granted by any state to navigate in some particular sea, without hindrance or molestation.

PASSUMAH, a district situated on the west coast of Sumatra. It is an extensive and populous country, governed by four independent chiefs, who acknowledge the sovereignty of the sultan of Palembang.

PASTEBOARD, a kind of thick paper, formed of several single sheets pasted one upon another. The chief use of pasteboard is for binding books, making letter-cases, and other articles.

PASTERN *of a* HORSE, in the manège, is the distance between the joint next the foot and the coronet of the hoof. This part should be short, especially in middle sized-horses, because long pasterns are weak, and cannot so well endure travelling.

PASTIL, or PASTEL, amongst painters, a kind of paste which is made of different colours, ground up with gum-water, in order to form crayons.

PASTIL, in *Pharmacy*, is a dry composition of sweet-smelling resins, aromatic woods, and the like, which is sometimes burnt to clear and scent the air of a chamber.

PASTIME, any sport, amusement, or diversion. Pastimes of some kind seem to be absolutely necessary, and to none more than to the man of study; for the most vigorous mind cannot bear to be always kept on the stretch. The sports, amusements, pleasures, and recreations, of our ancestors, as described by Fitz-Stephen,[9] added strength and agility to the wheels of state mechanism, whilst they had a direct tendency towards utility. Most of these ancient recreations are resolvable into the public defence of the state against the attacks of a foreign enemy. The play at ball, derived from the Romans, was first introduced by this author as the common exercise of every school-boy. The performance was in a field, whither the most substantial and considerable citizens resorted to give encouragement and countenance to this feat of agility. The intention of the amusement at this period of time was to render the juvenile race active, nimble, and vigorous; qualities which were requisite whenever their assistance should be wanted for the protection of their country. The next species of pastime indeed does not appear to have had this tendency; but it was only, as it should seem, an annual custom. This was cock-fighting. The author informs us, that in the afternoon of Shrove-Tuesday, upon which day this custom prevailed, they concluded it by throwing the ball; which seems to insinuate that cock-fighting was merely in conformity to ancient usage, and limited only to part of the day, in order to make way for a more laudable performance. We may reasonably suppose, although our author is entirely silent upon this head, that whilst cock-fighting was going on, cock-throwing was the sport of the lowest class of people, who could not afford the expense of the former. Another species of manly exercise was truly martial, and intended to qualify the adventurers for military discipline. "Every Friday in Lent," says Fitz-Stephen, "a company of young men comes into the field on horseback, attended and conducted by the best horsemen; then march forth the sons of the citizens, and other young men, with disarmed lances and shields, and there practise feats of war. Many courtiers likewise, when the king is near the spot, and attendants upon noblemen, do repair to these exercises; and while the hope of victory does inflame their minds, they show by good proof how serviceable they would be in martial affairs." This is evidently of Roman descent, and immediately brings to our recollection the *ludus Trojæ*, supposed to be the invention, as it was the common exercise, of Ascanius. The common people, in this age of masculine manners, made every amusement where strength was exerted the subject-matter of instruction and improvement. They were taught to exert their bodily strength in the maintenance of their country's rights; and their minds were also improved by such exertion, being formed to every manly and generous principle.

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[1] See Leo of Modena, iii. c. 3, and the Rabbin.

[2] 1st Corinthians, v. 7.

[3] Romans, iii. 25; Hebrews, ix. 14.

[4] John, xviii. 28.

[5] Exodus, xii. 6.

[6] Matthew, xxvii. 46; Hebrews, i. 2.

[7] Luke, xxiii. 44.

[8] Colossians, i. 24.

[9] Otherwise called William Stephanides, a monk of Canterbury, who lived in the reigns of Stephen and Richard I. He wrote a Latin treatise, in which he gives an account of the several pastimes which were countenanced in his time. Bale, in his writings, draws a pleasing portrait of this person; and he is likewise sketched with much commendation by Leland. "The time which other people usually misemployed in an idle and frivolous manner," says Bale, "he consecrated to inquiries which tended to increase the fame and dignity of his country; in doing which, he was not unworthy of being compared to Plato, for, like him, he made the study of men and heaven his constant exercise."

In the intervals of industry and labour, commonly called the holidays, indolence and inactivity, which at this day prevail, were found only in those whose lives were distempered with age or infirmity. The view which Fitz-Stephen gives us of the Easter holidays is animated. "In Easter holydays they fight battles upon the water. A shield is hanged upon a pole fixed in the middle of the stream. A boat is prepared without oars, to be borne along by the violence of the water; and in the forepart thereof standeth a young man, ready to give charge upon the shield with his lance. If so be that he break his lance against the shield, and doth not fall, he is thought to have performed a worthy deed. If without breaking his lance he runs strongly against the shield, down he falleth into the water; for the boat is violently forced with the tide; but on each side of the shield ride two boats, furnished with young men, who recover him who falleth as soon as they may. In the holydays all the summer the youths are exercised in leaping, dancing, shooting, wrestling, casting the stone, and practising their shields; and the maidens trip with their timbrels, and dance as long as they can well see. In winter, every holyday before dinner, the boars prepared for brawn are set to fight, or else bulls or bears are baited."

These were the recreative pursuits to which our sturdy forefathers devoted their leisure, as far back as the year 1130. Their immediate successors breathed the same generous spirit. In the year 1222, being the sixth year of Henry III., we find, that certain masters in exercises of this kind made a public profession of their instructions and discipline, which they imparted to those who were desirous of attaining excellence and victory in these honourable achievements. About this period, persons of better rank and family introduced the play of *tennis*,[1] and erected courts or oblong edifices for the performance of the exercise.

About the year 1253, that is, in the 38th year of Henry III. the *quintan* was a sport much in fashion in almost every part of the kingdom. This contrivance consisted of an upright post firmly fixed in the ground, and having upon the top of it a cross piece of wood, moveable upon a spindle, one end of which was broad like the flat part of a halbert, whilst at the other end was hung a bag of sand. The exercise was performed on horseback. The masterly performance was, when, upon the broad part being struck with a lance, which sometimes broke it, the assailant rode swiftly on, so as to avoid being struck on the back by the bag of sand, which turned round instantly upon the stroke being given, with a very swift motion. He who executed this feat in the most dexterous manner was declared victor, and the prize to which he became entitled was a peacock. But if, upon the aim being taken, the competitor miscarried in striking at the broadside, his want of skill became the ridicule and contempt of the spectators.

Dr Plott, in his Natural History of Oxfordshire, tells us that this pastime was in practice in his time at Deddington, in that county. "They first," says he, "fixed a post perpendicularly in the ground, and then placed a small piece of timber upon the top of it, fastened on a spindle, with a board nailed to it on one end, and a bag of sand hanging at the other. Against this board they anciently rode with spears. Now as I saw it at Deddington only with strong staves, which violently bringing about the bag of sand, if they make not good speed away, it strikes them on the neck or shoulders, and sometimes perhaps strikes them down from their horses; the great design of the sport being to try the agility both of man and horse, and to break the board; which, whoever did, was accounted conqueror; for whom heretofore there was some reward always appointed."

These feats of honourable contest were succeeded by the gilded banners of exhibition, and all the long train of dependents in the interest of indolence. For the writers of these times inform us, that the soft pleasures of the stage forced the passes to public favour in the year 1391, and likewise in the year 1409; so that utility, which before stood upon the right hand of pleasure, was now ordered to withdraw for a season. The drama, it seems, was attempted by a set of useless and insignificant persons called *parish-clerks*, who, because they had the knowledge of the alphabet, ignorantly presumed that this included every other species of knowledge. The subject was truly serious, being the creation of the world; but the performance must have been ludicrous. It was, however, honoured with the attendance of noble personages; and royalty itself deigned to cast a favourable eye upon it, for the king and queen were present. These interludes lasted no longer than the time requisite for the former confederacy of utility and pleasure to resume its powers. The lance, the shield, the ball, and the equestrian procession, came forward again, and put the dramatic usurper to flight. After this period, these objects of generous pleasure seem to have had their audience of leave; and one general object, no less manly than the former, filled their stations, we mean archery. This continued till the reign of Charles I.; for we find in many hospitals founded during that reign, that amongst the articles of benefaction recorded upon their walls was this singular provision, *arms for the boys*, which signified *bows and arrows*.

There are, at this day, many places which were formerly resorted to for the practice of this noble art, distinguished by appellations which indicate their ancient usage; such as Brentford Butts, Newington Butts, and many others of the like denomination. It appears from 33 Henry VIII. that, by the intrusion of other pernicious games, archery had for a long time been disused; and to revive it this statute was enacted. It seems that the bows of the best kind were made of yew; and, that this wood might be readily obtained for the purpose, yew-trees were planted in church-yards. The sons of those only who were persons of fortune and fashion, if under seventeen years of age, were permitted to use such bows. The words of the statute are singular, and run thus: "No person under seventeen years, except he, or his father or mother, have lands or tenements to the yearly value of ten pounds, or be worth in value or moveables the sum of forty marks sterling, shall shoot with any bow of yew, which shall be bought for him, after the feast of our lady next coming, under the pain to lose and forfeit six shillings and eightpence." Upon these words two observations present themselves. One is, that the yew-wood, not being so common as other wood, might probably be soon found deficient, as it was the best wood for making bows, if the use of it had not been confined to particular ages and persons, as young people wantonly destroy what is put into their hands for useful purposes. The other observation is, that the age of seventeen is by this statute distinguished as the age of discretion, when young people are more attentive and considerate in things of private concernment. This statute makes provision of other kinds of wood for the common people; and to the intent that every person may have bows of mean price, it enacts, that every bowyer shall, for every bow that he makes of yew, make four other bows, meet to shoot with, of elm, witch-hazel, ash, or other wood apt for the same, under pain of losing and forfeiting, for every such bow so lacking, the sum of three shillings and fourpence. It seems there was a species of yew at this time called *elk*, a wood which was stronger and more pliant than the common yew mentioned in the statute, and the price of which it fixed. "Moreover, no bowyer shall sell or put to sale to any of the king's subjects, any bow of yew of the tax called *elk*, above the price of three shillings and fourpence, under the pain to forfeit twenty shillings for every bow sold above the said price."

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[1] The word *tennis* seems to owe its origin to the French language; and if so, the game is probably of French invention. Yet the word *tenez* will hardly afford incontrovertible evidence upon this subject. For the holding or keeping possession of the ball is no part of the game, but rather a circumstance casually attending it; since, during the performance of it, the ball is in continual motion, so that there can be no *tenez* at this juncture. Perhaps some town in France called *Tennois* may have been the place where the balls were first made, and the game first introduced.

About the beginning of the reign of James I. military prowess appears to have sounded a retreat. This king, to gratify the importunity of the common people, and at the same time to obviate his own fears, published a book of sports, in which the people had some time before been indulged on Sunday evenings, but which had lately been prohibited. These sports consisted of dancing, singing, wrestling, church ales, and other profanations of that day.

Charles, his successor, wisely abolished these sports. The act of Charles states in part the several amusements, by which we may conjecture what were the remainder as stated in the book of sports by James. It is necessary to transcribe the portion of the act relating to this subject. "Forasmuch as there is nothing more acceptable to God, than the true and sincere worship of Him, and service according to His holy will, and that the holy keeping of the Lord's day is a principal part of the service of God, which in many places of this realm hath been, and now is, prophaned and neglected by a disorderly sort of people, in exercising and frequenting bear-baiting, bull-baiting, interludes, and common-plays, and other unlawful exercises and pastimes, neglecting divine service both in their own parishes and elsewhere: Be it enacted, that from and after forty days next after the end of this session of parliament, there shall be no meetings, assemblies, or concourse of people, out of their own parishes, on the Lord's day, within this realm of England, or any the dominions thereof, for any sports or pastimes whatsoever; nor any bear-baiting, bull-baiting, interludes, common-plays, or other unlawful exercises or pastimes, used by any person or persons within their own parishes; and that every person and persons offending in any of the said premises, shall forfeit for every offence the sum of three shillings and fourpence; the same to be employed and converted to the use of the poor of the parish where such offence shall be committed." All this was no doubt very proper, and showed the piety of the unfortunate monarch by whom it was enacted. But this age witnessed the close of the ancient manly sports of Britain.

PASTO, a province of Colombia, in South America, in the department of Cauca. It is the most southerly province in the department, lying next to Quito, within half a degree of the equator, and under the seventy-sixth meridian west from Greenwich. The triple chain of the Magdalena cordilleras, and the double chain of those of Quito, here unite into one mass, which is called by Humboldt the Knot of the Mountains of Los Pastos. The inhabited parts of Pasto are elevated 10,000 feet above the level of the sea. It is the Thibet of equinoctial America. As its name indicates, it abounds in excellent pastures, and consequently in cattle, and is watered by several considerable rivers. Although it is situated at a great height, yet the temperature is also high, from its vicinity to the equator; and wheat and other productions of such climates are found here. In the woods grows the tree which yields a resin called in that country *mopa-mopa*, from which the natives make a very beautiful varnish, of so durable a quality that it cannot be softened by boiling water, nor dissolved by acids. In its most northern part rises the volcano of Pasto, of which the last eruption took place in the year 1727. The principal town, also called Pasto, is situated about eighty miles south-south-west from Popayan, in latitude 1. 15. north, and longitude 76. 46. west. It is a considerable place, containing some seven or eight thousand inhabitants, who are celebrated for the manufacture of a peculiar species of cabinet-work. That portion of the grain of Pasto which is exported is principally conveyed to Popayan.

PASTOPHORI, amongst the ancients, were priests whose office it was to carry the images, along with the shrines, of the gods, at solemn festivals, when they prayed to them for rain, fair weather, or the like. In Sylla's time, the Greeks had a college of this order of priests. The cells or apartments near the temples, where the pastophori lived, were called *pastophoria*; and there were several lodging rooms for the priests of a similar kind in the temple of Jerusalem.

PATA Isle, one of the small Sooloo Islands, lying due north from Sooloo. It is inhabited, and contains a good stock of cattle; and it has also pits of saltpetre.

PATÆCI, in *Mythology*, images of gods which the Phœnicians carried upon the prows of their gallies. Herodotus denominates them πατωικοι. The word is Phœnician, and derived from *pethica*, signifying *titulus*.[1] But Scaliger does not agree in this, and Morin derives it from πιθηκος, *monkey*, an animal which had been an object of worship amongst the Egyptians, and might therefore have been honoured by their neighbours. Mr Elsner has observed, however, that Herodotus does not call the patæci *gods*; but that they obtained this dignity from the liberality of Hesychius, Suidas, and other ancient lexicographers, who place them at the stern of ships, whereas Herodotus placed them at the prow. Scaliger, Bochart, and Selden have bestowed some pains upon this subject; and Morin has likewise inserted a learned dissertation concerning it, in the *Mémoires de l'Acad. des Inscript. et des Belles Lettres*; but Mr Elsner thinks it defective in point of evidence.

PATAGONIA, or Land of Magalhaens, a very large tract of country, occupying the whole southern portion of South America beyond the united provinces of the Rio de la Plata, with the exception of portions of its western and eastern coasts, which form parts of Chili and of Buenos Ayres respectively. Its limits on the north have repeatedly been altered. In the year 1740 an imaginary line was drawn across the continent, in about 35° of south latitude, and which separated the possessions of the Spaniards from the territory of the Indians. But this boundary was never respected by either party, inroads having been repeatedly made by both into the neighbouring country. In 1822 the government of Buenos Ayres built fortresses on a frontier which extended to nearly the 38th degree of south latitude, with the intention of repelling the roving tribes from all the country which lies to the north of that parallel. The Indians, however, never recognised this line of demarcation, and made frequent irruptions into the possessions of Buenos Ayres, plundering the country, and committing dreadful havoc. From this debateable land Patagonia extends to the 56th degree of south latitude; a parallel including Cape Horn, which is in fact a small island, and the most southerly of those lying immediately contiguous to Tierra del Fuego. In longitude it extends from the

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[1] See Bocchart's *Chanaan*, lib. ii. cap. 3.

63d to the 75th meridians west from Greenwich. Its length, including Cape Horn, is above one thousand miles; but its breadth at the widest is not much more than one third of that space, and it gradually narrows to a point at the southern extremity, where the land bends in a curve to the south-east. The interior of this vast country is but little known, only the sea-coast territory and the numerous islands having been as yet explored to any extent. Indeed, until very lately, our knowledge of any part of it, with the exception of the eastern coast, was confined to isolated and often widely-separated portions of the country; but a survey of the coasts, taken between the years 1826 and 1836, by orders of the British government, and also some recent voyages, undertaken in vessels belonging to Great Britain, the United States, and other countries, have gone far to supply this blank in geography.[1] We shall here describe the country under three heads, viz. Western Patagonia; Southern Patagonia, including Tierra del Fuego, and all the other islands; and Eastern Patagonia.

Western Patagonia. The great cordillera of the Andes, which is known to traverse the continent almost from end to end without a break, gradually decreases in elevation as it reaches the higher southern latitudes. In the neighbourhood of the equator it rises in several places more than 20,000 feet above the level of the sea; at Santiago of Chili, in latitude 34° south nearly, the highest land is 14,000 feet; farther south it continues to decline; and from the island of Chiloe to the Strait of Magalhaens,[2] Captain King estimates the average height at 3000 feet. He adds, however, that "there are some mountains which may be between five and six thousand feet high." About the parallel of 40° the coast begins to assume, and retains to its furthest extremity, a very different appearance from that which it exhibits to the northward. On the coast of Chili, and indeed along the whole of the western shore of the continent, to its northern extremity, a belt of comparatively low land interposes between the ocean and the cordillera of the Andes, and which affords but very few places of shelter for vessels. But southward of the parallel specified, the base of the mountain chain is washed by the Pacific, the waters of which, flowing as it were into the deep ravines that wind through its ramifications, form numerous channels, sounds, and gulfs, and in many instances insulate considerable portions of land. Indeed the whole western coast of Patagonia is girdled by a chain of large islands and extensive archipelagos, barren to seaward, but impenetrably wooded towards the mainland. Of these the most conspicuous are the Archipelago of Chonos, Wellington Island, the Archipelago of Madre de Dios, Hanover Island, and Queen Adelaide's Archipelago. The land of Tres Montes is however an exception, being a peninsula, and the only part of the continent, within the above limits, that is exposed to the swell of the ocean. It forms the northern part of the Gulf of Penas, and is connected with the mainland by a narrow isthmus called Ofqui, over which the Indians, in travelling along the coast, carry their canoes, to avoid the risk of passing round the peninsula, an undertaking of extreme danger. It was here that the celebrated Byron, ancestor of the great poet, and his shipwrecked companions, crossed over with their Indian guides; but the route is not much frequented, for this part of the coast, like all the rest, is very thinly peopled, and the task of pulling their canoes to pieces and reconstructing them, which is absolutely necessary, is too great to be performed, except upon occasions of extraordinary emergency.

The largest river of the coast to the south of the Archipelago of Chiloe is called San Tadeo. It is, however, of inconsiderable size, and falls into the Gulf of St Estevan, over a shallow bar, upon which there is but very little depth of water. At the head of this gulf is St Quentin's Sound, of easy access, and affording excellent anchorage. The Guaiancco Islands form the southern head of the Gulf of Penas. These are succeeded by Wellington Island, separated from the continent by the Mesier Channel, the extent of which is about 160 miles, and of course the island which it insulates is nearly of the same length; but its breadth at the greatest does not exceed sixty or seventy miles. The Mesier Channel joins the Strait of Concepcion behind the Madre de Dios Archipelago, at the Brazo Ancho of Sarmiento. About thirty miles within the Mesier Channel, Captain King says, the west side appears to be formed by a succession of large islands; and on both sides of the channel the coast is hilly, but not very elevated, there being in many places much low and generally thickly-wooded land. The same character distinguishes the Mesier from all the other channels. In this locality the trees are nearly of the same description as those which are found in all parts between Cape Tres Montes and the Strait of Magalhaens. Of these the most common are an evergreen beech, a birch-like beech, the winter's bark, a tree resembling a cypress, of which the Indians make their spears, and a very hard and heavy wood, of a red colour, which is used as fuel. A great quantity of timber grows in the vicinity of Mesier Channel, but it attains no height, and, from the humidity of the climate, is found to be decayed at the heart, and of very little use. About half way through, the Mesier Channel changes its character entirely, becoming very narrow, tortuous, and strewed with islands, whilst the land on either side rises abruptly from the water in mountainous and precipitous ridges. This character it preserves to its junction with the Wide Channel, in which the breadth increases to two miles and a half, and then running thirty-four miles with a direct and unimpeded course, falls into the Strait of Concepcion. This strait separates the archipelago of Madre de Dios from the mainland, which in this part is much intersected by deep sounds. The principal of these is called the Canal of St Andrew, and it extends to the base of the snowy range of the cordillera, which is described to be "suddenly and boldly closed by tremendous and astonishing glaciers." Sarmiento's Puerto Buono, as its name indicates, is a safe and commodious harbour, the depth of water being only nine fathoms all over, an advantage which few ports in this quarter afford. Behind Hanover Island, which is separated from the mainland by Concepcion Strait, the continent is very much intersected by extensive sounds trending deeply into the land, like the St Andrew Channel, to the base of the Andes. South of Hanover Island is Queen Adelaide's Archipelago, through which there are several channels that communicate with the Strait of Magalhaens. The principal of these, called Smyth's Channel, falls into the strait at Cape Tamar.

The general character of Western Patagonia, given by its recent explorers, is very unfavourable. Wood and water are indeed abundant everywhere; fish are easily caught; and the steamer or race-horse duck, geese, wild-ducks, and other smaller birds, are everywhere numerous; but of any other useful productions the country is quite destitute. "If," says Lieutenant Skyring, "we force a passage through the woods, it is over fallen trees and moss; if we walk over open, flat ground, we find the place a swamp; and if we climb the hills, we travel over a continuous rock, generally covered by a spongy moss, and entirely destitute of soil of any description." The forests are so dense as to be impervious to the sun's rays, so that the rain, which falls here incessantly, is never carried away by evaporation. The consequence is, that every foot of earth, and every tree and shrub, on these inhospitable shores, is always thoroughly wet. Of course the country is uninhabitable, except by savages. Clouds, wind, and rain, only cease their annoyance during the very few days on which the wind is easterly, or perhaps southerly. Probably there are not ten days in twelve months on which rain or snow does not fall, and not thirty on which it does not blow strongly. But it is mild, and the temperature is surprisingly uniform throughout the year.

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[1] The surveying voyages to which allusion has been made, are those of the Adventure and Beagle. In drawing up our account of Patagonia, we have been much indebted to two notices of these expeditions which appeared in the Journal of the Geographical Society; the first, by Captain King, commander of the expedition, being contained in vol. i., and the other, by Sir John Barrow, in vol. vi. part ii.

[2] With regard to the orthography of this great navigator's name, Captain King says in a note, "There has existed much difference of opinion as to the correct mode of spelling this name. The French and English usually write it Magellan, and the Spaniards Magallanes; but by the Portuguese, and he was a native of Portugal, it is universally written Magalhães......I have convinced myself of the propriety of following the Portuguese orthography for a name which to this day is very common both in Portugal and Brazil."

The most striking feature of *Southern Patagonia* is the long and comparatively narrow channel called the Strait of Magalhaens, which separates Tierra del Fuego, and a great number of other islands, from the mainland. The manner in which the land, continental as well as insular, is penetrated in all directions by large and small arms of the sea, is such as to defy verbal description. The indentations frequently assume the character of immense inland seas, one of which, called Otway Water, nearly insulates a large portion of the continent, to which the name of Brunswick Peninsula has been given. A natural canal connects Otway Water with Skyring Water, which, stretching from east to west, along with another arm of the sea called Obstruction Sound, trending in a semicircle from north to south, nearly cuts off another large portion of the continent, which has been called King William IV.'s Land. The south-eastern shore of the Otway Water is high, rocky, and generally precipitous; but the northern coast is formed by low, undulating, grassy plains, wholly destitute of timber. The shores of Skyring Water have the same general character. In some parts the country is wooded, and possesses a dry and light but tolerably good soil. Captain King thus speaks of the survey which had been made of this part of Patagonia. "In this examination, the southern part of the cordillera was ascertained. The eastern shores of the interior channels were found to be low plains, with no hills nor mountains visible in the distance; and such being the feature also of the northern shores of the Otway and Skyring Waters, it is probable that all the country to the east of the sounds is a continued pampa or plain." Traces of Indians were observed, but they do not appear to inhabit the shores of these interior sounds, at least permanently. No guanacoes were discovered, but several large herds of deer were observed feeding on the shores. Sea-otters and black-necked swans in great numbers were the only other living things observed in these dreary solitudes.

"The Strait of Magalhaens," says Captain King, "being a transverse section of the continent, exhibits a very good view of its geological structure. The strait may be divided into three portions, the western, central, and eastern. The western end and centre are of primitive character, rugged, and very mountainous; whilst the eastern portion is of a recent formation, and low. The western part is composed of a succession of stratified rocks, a difference at once distinguishable by the form and nature of the ranges, and the direction of the shores; the hills are irregularly heaped together; the sounds are intricate and tortuous in their course; and the shores are formed by deep sinuosities and prominently projecting headlands. The channels also are studded with innumerable islands and rocks, which are extremely dangerous for navigation. Near the centre of the strait, the rock being clay-slate, the mountains are higher, and more precipitous and rugged in their outline, and consequently not easily to be ascended. They are in general three thousand, but some are found to be four thousand feet in height; and one, Mount Sarmiento, is upwards of six thousand feet high, and is covered throughout the year with snow. The line of perpetual snow in the strait seems to be about three thousand five hundred or four thousand feet above the sea. The strait here is quite free from islands; and it is a remarkable fact, that where the greenstone formation terminates, there the islands cease to appear." The slate formation continues as far as Fresh-Water Bay, situated about the middle of the eastern shore of Brunswick Peninsula, Cape Negro forming its northern extremity, and projecting from the narrow isthmus which unites the peninsula with the mainland. At Cape Negro the clay formation commences, and in that portion of the strait to the eastward of it the hills are remarkable for the regularity and parallelism of their direction, and their general resemblance to each other. Captain King thus concludes his geological observations: "The irregularity of the topographic features of the more western portion of the strait, combined with its confused assemblage and immense number of islands and rocks, the regularity of the strata, the coinciding parallelism of all the bays, channels, and sounds, and the total absence of islands in the central portion or slate formation, together with the remarkable similarity of the direction of the hills and coast line, and the stratification of the north-eastern tract, which is very different from that of the centre, are very striking facts, and, geologically considered, are of great interest."

The character of the vegetation is also very interesting, not so much from the variety of plants, as from their stunted growth to the westward, their luxuriance in the centre, and the total absence of trees to the eastward. This remarkable dissimilarity, of course, arises from the soil differing very much in these several localities. Light and thin in the west and east, it is unfit for plants which take a deep root; but in the centre, where there are large valleys irrigated by numerous streams, which swell in the winter months, and deposit a great quantity of alluvium, a good superficial soil is formed, and here accordingly the shrubs and plants become particularly luxuriant and productive, whilst trees of several feet in diameter are numerous. The trees are similar to those already mentioned as belonging to Western Patagonia, and they are not of much value. It is remarkable that, in this rigorous climate, the veronica, and even the fuchsia, were found in full flower within a short distance of the base of a mountain, covered about two thirds down with snow, and with a temperature of 36°. During summer, Captain King found it at night as low as 29°, yet the most delicate plants received no injury from the cold. This is singular enough; but the following facts relative to climate are still more remarkable. "I have occasionally," says this navigator, "during the summer, been up the greater part of the night at my observatory, with the internal as well as the external thermometers as low as freezing point, without being particularly warmly clad, and yet not feeling the least cold; and in the winter the thermometer, on similar occasions, has been at 24° and 26°, without my suffering the slightest inconvenience. This I attributed at the time to the peculiar stillness of the air, although within a short distance in the offing, and overhead, the wind was high." The water of the ocean near the surface is here so much warmer than the air, that in the middle of winter, which is June, a difference of no less than thirty degress has been observed, on which occasions the sea was covered with a cloud of vapour, the result of a well-known law. Parrots and humming-birds, generally the inhabitants of warm regions, are very numerous in the southern and western parts of the strait; a fact which proves that the climate is mild although the temperature be comparatively low.

Tierra del Fuego is divided into three islands by two channels or sounds. The most westerly of these is high and rugged; and although in the valleys, ravines, and sheltered nooks, there is no want of vegetation, yet, in comparison with the eastern part of the strait, it has a very dismal and uninviting aspect. It bears the appropriate name of South Desolation. To the east of it lies Clarence Island, which is only fifty-two miles in length by twenty-three in breadth. It is equally rocky with the former, but has a much more verdant and agreeable appearance. These two islands are of course surrounded by others without either number or name; and the southern and western part of Tierra del Fuego may be briefly described by stating, that deep but narrow arms of the sea intersect high mountainous islands, the summits of which are covered with snow, whilst their steep and rocky shores are more than partially covered with evergreen woods. Throughout the year cloudy weather prevails, much rain falls, and fine days are very rare. The natives, too, unlike those in other parts of the country, are an ill-conditioned race, low in stature, badly formed in body, and of a colour as dark as old mahogany. The eastern island, which is by far the largest of the three, is known on our charts by the name of King Charles's South Land. The northern part partakes of the geological character of the eastern portion of the strait; the centre is a continuation of the slate formation; and the south shore, or seaward coast line, is chiefly composed of greenstone. The eastern portion of Tierra del Fuego is a better country than any south of the forty-fifth parallel. The eastern shore towards the south part is lofty, but near the northern part it is very low. The interior is also low, with extensive plains abounding with guanacoes. The natives are a much better race of men than those in the western part of Tierra del Fuego, and the climate is also more favourable. At Port Famine, in the Strait of Magalhaens, situated in latitude 53. $38\frac{1}{4}$. south, and longitude 70. 54. west from Greenwich, Captain King took careful observations of the climate from the beginning of January till the middle of August. From his tables it appears that the mean temperature for the autumnal period, the months of February, March, and April, was 47° 2′; the maximum and minimum being respectively 68° and 28°. For the three following months, or the winter period, the mean temperature was 34° 5′, and the maximum and minimum 49° 5′ and 12° 6′ respectively. The natives of this territory are like those of Eastern Patagonia, but they have no horses. Balls, and bows and arrows, are their arms and hunting weapons. They depend for subsistence chiefly on seals, guanacoes, and birds. As a native of Tierra del Fuego is seldom out of sight of his canoe, or a wigwam, the only constructions on which he exercises his skill, some idea of these must be given. The canoe is made of several large pieces of bark sewed together. Its shape is nearly that which would be assumed by the strong bark of a tree from twelve to twenty feet in length, and about eighteen inches or two feet in diameter, when separated from the solid wood in one piece, and joined at the ends, but kept open towards the middle by means of sticks. It is ballasted by clay, and always carries a small fire. There are two kinds of wigwams, one of which is made of small straight trees, the upper ends of which are united, whilst the lower form a circle. The other is formed by branches stuck in the ground, then bent together at the top, and slightly covered with skins, bark, grass, or leafy twigs. A small aperture is left for the smoke to escape by, but here the rain as readily finds entrance.

To the south of Tierra del Fuego are a vast number of islands, the largest of which are called Hoste and Navarin Islands. The south shores of these consist of hornblende, which is the principal rock of which the islands in the neighbourhood, as well as of that of Cape Horn itself, are composed. The south summit of this small but celebrated island is situated in 55. 58. 41. of south latitude, and 67. 21. 14. of longitude west from Greenwich. With the most boisterous and humid climate on the globe, and with a low but eminently uniform temperature, vegetation flourishes here with surprising beauty and luxuriance. Some causes hitherto unexplained considerably modify the assigned law of diminution of temperature in proportion to elevation, for here it does not appear to hold true. Captain Foster, an accurate observer, says, that the character of vegetation on the mountains of Staten Island and Cape Horn did not vary in the least from that of the lowland plains. The hills about Cape Horn are very rarely covered with snow, yet, from the temperature at the level of the sea, and the known altitude of the hills, this ought to be the case.

It may be observed, that there are several other islands which lie still farther south than Cape Horn; but although clothed with vegetation, they are small, and do not appear to contain inhabitants. The vegetation of Horn Island is similar to that of Staten Island, which has been very fully described by several intelligent navigators. It is rendered remarkable by its position off the south-eastern extremity of the South American continent, by the peculiarity of its shape, it being so deeply indented by bays as to form nearly four different islands, and by the circumstance of its offering a good departure for ships bound to different parts of the Pacific, as well as a landfall for those returning from the islands situated in that quarter. It is about thirty-four miles in length from east to west, and its extreme breadth is about nine miles. Staten Island is separated from Tierra del Fuego by the Straits of Le Maire, in which there generally runs a very dangerous tide-rip. It is composed of an accumulation of lofty hills of clay-slate, separated by narrow ravines, little or no level ground being seen. The scenery of the island is wild and romantic in the extreme; and although rugged and uncultivated, it is grand and pleasing. It is clothed all over with luxuriant vegetation, consisting chiefly of beautiful evergreen trees, the most common being the antarctic beech, and a multitude of minor plants and shrubs, many of which bear excellent fruits. The seal, the otter, the rat, and the mouse, are the only quadrupeds on Staten Island; but birds are more numerous. It has long been the resort of vessels in search of seals, and they have in consequence become considerably less numerous than formerly. The climate of this island, like that of Tierra del Fuego, is extremely humid and boisterous, the sky being constantly charged with vapour. There are several harbours in Staten Island, but they are all, with one exception, confined to its northern side.

The eastern coast of Patagonia, from the entrance of the Strait of Magalhaens to the river Plata, is comparatively low. From Cape Virgins, at the mouth of the straits, to Port St Julian, in latitude 49. 15. 20. south, where porphyritic clay-stone commences, the coast is formed of clay cliffs horizontally stratified, and the country is undulating, with extensive pampas covered with grass and destitute of trees, like those of Buenos Ayres, which they otherwise resemble. "At Port St Julian," says Captain King, "the country becomes hilly, and continues so as far to the northward as latitude 44°, the rock being porphyritic. The clay formation to the southward has been likened to the appearance of the coast of Kent, and at a short distance it bears certainly a very great resemblance to it; but the cliffs, instead of being chalk, are composed of a soft marly clay, without any gravel or impressions of organic remains, excepting at Port St Julian, where fossil shells, both bivalves and univalves, are found imbedded in clay cliffs; and on the surface are lying strewed about large oyster-shells." In the clay formation there are three rivers, namely, the Gallegos, in latitude 51. 38.; Port Santa Cruz, in latitude 50. 7.; and

Port St Julian. The first does not extend farther into the interior than forty miles, and Port St Julian is of still smaller size. The Gallegos can only be entered at high water, and here the tide rises about forty-six feet, the stream being very strong. Port Santa Cruz appears to be a very considerable river. In the sketch of the surveying voyages communicated to the Geographical Society by Sir John Barrow, it is thus spoken of:—“ In a twenty days' excursion up the river Santa Cruz, we passed through a similar country, without variety, until extensive beds of lava were found overlying the whole country. We reached nearly to the eastern flank of the Andes; but, for want of provisions, could go no farther. The river was then, at two hundred miles from its mouth, almost as large, and quite as rapid, as at twenty miles from the sea. Perhaps it runs for a great distance along the base of the Andes, and so collects a great body of water; or it may run from a lake into which streams pour. Its water is not muddy. The current runs six knots an hour; none of our boats could pull against it anywhere. Its average width is two hundred yards, and its mean depth ten feet, perhaps more.” The same writer thus speaks of the country in general: “ One naturally asks why Eastern Patagonia should be condemned to perpetual sterility, while the western side of the same country, in the same parallel of latitude, is injured by too much rain? The prevailing westerly winds and the Andes are the causes. The winds bring much moisture from the Pacific, but they leave it all, condensed, on the west side of the mountains. After passing the cordillera, those same winds are very dry. Easterly winds are very rare upon the east coast; they are the only ones which carry rain to the almost deserts of Patagonia. Westward of the Andes, an east wind is dry, and free from clouds. All this country is exposed to severe cold weather in winter, and to excessive heat in summer. Great and sudden changes of temperature take place, when, after very hot weather, cold winds rush northwards with the fury of a hurricane. Even the wandering Indians avoid this region, and only cross it to get salt, or visit their burying places.” We are informed by Falconer, the Jesuit missionary, that after the dead have been interred twelve months, the graves are visited by the tribe, for the purpose of collecting the bones, and conveying them to their family sepulchres, where they are set up, and adorned with all the beads and ornaments which the friends and family of the deceased are able to collect for the occasion. The ceremony is performed by certain women of the tribe, whose peculiar office it is to attend to these rites. In corroboration of the Jesuit's testimony, Captain King informs us, that near Port Desire he had seen the graves of the Indians upon the summits of hills, but without the bodies, which he supposes to have in all probability been removed by the Indians. The Port Desire here mentioned is situated in lat. 47. 45. south, having a narrow entrance with strong tides, but affording in the offing very good anchorage, as well as shelter from the prevailing winds. Not many years before Spanish domination ceased in America, that government formed an establishment here; but, from the dry and parched nature of the land, it completely failed. Thirty miles to the northward is Cape Blanco, between which place and the Rio Negro, more than four hundred miles to the north, navigation is considered as dangerous, there being many extensive shoals, and strong tides. For an account of the Rio Negro, the most important river of Patagonia, see the article NEGRO, RIO. The Colorado, which rises near Mendoza, in La Plata, is also a very large stream, falling into the Atlantic in latitude 40. 0. nearly. It brings down a great quantity of water throughout the year, but as it does not run into any of the numerous ports near its opening, it is of no use to vessels as a place of shelter or anchorage.

The aboriginal natives of Patagonia are a tall and extremely robust race of men. Their bodies are bulky, and their heads and features large, but their hands and feet are small. Their limbs are neither so muscular nor so large boned as their height and apparent bulk would lead one to suppose; they are rounder and smoother than those of white men. Their colour is a rich reddish brown, rather darker than the hue of copper. Their heads are furnished with a profusion of rough, lank, and coarse black hair, which is tied above the temples by a fillet of plaited or twisted sinews; and they wear no other covering upon this part of their body. “ A large mantle,” says one of the recent voyagers, “ made of skins sewed together, loosely gathered about them, hanging from the shoulders to their ankles, adds so much to the bulkiness of their appearance, that one ought not to wonder at their having been called gigantic. I am not aware that any Patagonian has appeared during late years whose height exceeded six feet and some inches; but I see no reason to disbelieve the Jesuit Falkner's account of the Casique Caugapol, whose height, he says, was seven feet and some inches......Among two hundred or three hundred natives of Patagonia, scarcely half a dozen men are seen whose height is under five feet nine or ten inches; the women are proportionably tall. I have nowhere seen an assemblage of men and women whose *average* height and *apparent* bulk equalled that of the Patagonians. Tall and athletic as are many of the South Sea islanders, there are also many among their number who are slight and of lower stature. The Patagonians seem to be high shouldered, owing perhaps to their habit of folding their arms across the chest, in their mantles, and thus increasing their apparent height and bulk, because the mantles hang loosely, and almost touch the ground. Until actually measured, it is difficult to believe that they are not much taller than is the case.” This description is so precise, and, from measurements having been made, so satisfactory, that the question as to the actual size of the Patagonians may be regarded as completely set at rest. Is it more improbable that there should be races of men *above* the European standard, than it is that there should be races whose height is *below* it? Yet we know beyond a doubt that the Esquimaux are so.

With the exception of the head, little hair grows upon their bodies; and from the face it is carefully removed by shells or pincers. They do not disfigure their naturally coarse features by piercing either nose or lip, but they bedaub their body with white, black, or red paint, forming grotesque figures, such as circles around their eyes, or great marks across their faces. This ornamental body-painting is practised by all the different races of Patagonians, from Cape Horn to Buenos Ayres. On their feet and legs they wear boots made of the skins of horses' hind legs; spurs made of wood, but of iron if they can get it, balls (*bolas*), such as are used by the inhabitants of the pampas; whilst a long tapering lance, and a knife if it can be procured, complete their equipment. “ Mounted upon horses of a middle size,” says the writer already quoted, “ under fifteen hands high, and rather well bred, the Patagonians seem to be carried no better than dragoons who ride eighteen stone upon horses able to carry ten; yet they go at full speed, in chase of ostriches or guanacoes. When hunting or making long journeys, they often change horses. The women are dressed and booted like the men, with the addition of a half petticoat. They clean their hair, and plait it into two tails. Ornaments of brass, beads, bits of coloured glass, or such trifles, are prized by them. The huts of these wanderers are somewhat like gipsy tents. Poles are stuck in the ground, to which others are fixed. Over them are thrown the skins of animals, an irregular tilt-like hut being thus formed.” It is to be observed, that the inhabitants of Tierra del Fuego, and of the islands to the south and south-west, where the climate is so singularly mild, wear little or no clothing. The Patagonians appear to possess nothing like towns, but lead a wandering and unsettled life, somewhat resembling that of the Tartars.

The *Falkland* or *Malouine Islands*, being situated off the coast of Patagonia, may, in a geographical point of view, be considered as belonging to it. This group consists of two large islands and a number of small ones, some of which are mere rocks, the whole being situated between 50. 0. and 51. 20. of south latitude, nearly opposite the southern extremity of Patagonia, which is the nearest land. The two large islands, which are separated from each other by a broad channel, are called Eastern and Western Falkland; the names of the others it is unnecessary to specify. East Falkland Island is favourably situated, both for colonization and for the refreshment of vessels bound round Cape Horn. It has other advantages, such as excellent harbours, abundance of wild cattle, and antiscorbutic herbs, which point it out as a desirable resort for ships. The climate is upon the whole mild, the general range of the thermometer being in winter from 30° to 50°, and in summer from 50° to 75°. The weather is rather unsettled; but neither rain, snow, nor hail falls here in such abundance as in Southern and Western Patagonia, whilst it is free from the parching dryness of the eastern coast. The soil is good, producing spontaneously different kinds of vegetables; and wheat, flax, potatoes, turnips, and the like, have here been very successfully cultivated; but the island is destitute of trees. For fuel, peat and turf, which are abundant, are used, and also two or three species of shrubs, which are found growing all over the island. Herds of horned cattle, hogs, and horses, all wild, are plentiful; whilst rabbits, foxes, and game, especially wild geese and ducks, are extremely numerous. Fish abounds in all the bays and inlets, and those most common, when salted, are thought superior to cod. Seals are found on the island, or on the neighbouring rocks; and hair-seals, lions and elephants as they are called, abound along the shores. Many black whales have also been caught in its neighbourhood, in consequence of which the island has of late years been much resorted to by fishing-vessels belonging to various nations. The Falkland Islands were uninhabited when first discovered, and, with the exception of occasional and transient residents, have still remained so; yet their position will always render them important in the estimation of commercial nations. In the year 1766 the English formed a settlement on one of them; but it was destroyed in 1770 by a Spanish expedition from Buenos Ayres. Of late years measures have been taken by the Argentine Republic for forming an establishment here; that government laying claim to sovereignty and jurisdiction, not only over the Falkland Islands, but likewise over Tierra del Fuego, Cape Horn, and the islands adjacent in the Atlantic Ocean, as having succeeded to the sovereign rights of Spain. This claim has been resisted; but it is unnecessary to enter into the merits of what seems based on so singular an assumption. Besides, it does not appear to be very material to whom they belong; the point of importance is their colonization, which would be highly advantageous to vessels navigating these seas.

It seems highly probable that Magalhaens was the original discoverer of the southern coast of Patagonia and the northern coast of Tierra del Fuego, as well as of the strait which bears his name. Sir Francis Drake passed the strait in the year 1578; and being driven by storms to the south, discovered the western and south-western coast of Tierra del Fuego, and also Cape Horn; although the honour of the discovery of the latter has generally been ascribed to Jacob Le Maire, a Dutchman in the service of the states of Holland. In the year 1616, this navigator was the first who doubled that terminus of South America, and called it Cape Horn, after a village in Holland. Proceeding in a north-easterly direction, he crossed the strait which bears his name, and discovered Staten Island, which he so designated after the states of Holland. It is supposed that Davies, one of the companions of Cavendish, in his voyage to the South Seas in 1592, was the first person who saw the Falkland Islands; but they were not, properly speaking, discovered till the year 1594, when Sir Richard Hawkins examined them, and called them in honour of his queen and himself, Hawkins' Maiden Land. The name, however, was subsequently changed to Falkland Islands by Strong, another English navigator. During the early part of the eighteenth century, they were re-discovered by some French navigators; and hence the origin of the French name, Malouine Islands. To Captain Cook we are indebted for the first accurate account of the south-eastern coast of Tierra del Fuego, which he explored in 1774; and so little was known concerning it before this period, that when actually in sight of Cape Horn, he was unable to decide whether it was a detached island or a part of Tierra del Fuego. Amongst the other distinguished names connected with the discovery or investigation of this part of the South American continent, are those of Sarmiento (whose account of a voyage down the western coast, and through the Strait of Magalhaens, has never been surpassed), Sir John Narborough, Cordova, Byron, Willis, Carteret, Bougainville, and Weddel. To these may now be added the names of the commanders of the recent expedition, Captains King, Stokes, and Fitzroy. It only remains to be noticed, that although repeated attempts have been made to form permanent settlements in Patagonia, or upon the neighbouring islands, particularly by the Spaniards, none of these has ever succeeded. With regard to population, it must be quite obvious that no accurate idea can be formed. It has, however, been estimated at 200,000, though from what data we know not. By far the greatest part of the country, that which stretches along the eastern side of the Andes, from their base to the Atlantic Ocean, is altogether unknown, with the exception of a very few places upon the coast. It is quite possible, therefore, that the inhabitants may be far more numerous in this region than is supposed; but the general sterility of the country holds out little prospect of any great commercial advantages to be gained by intercourse with them, except in the precious metals, which are doubtless to be found in the Patagonian Andes. (R. R. R.)

PATAN, a town of Hindustan, in the province of Ajmeer, and district of Harowty, situated on the south-eastern side of the Chumbul. It is the capital of a district containing two villages, and has a handsome temple, dedicated to Vishnu, which was erected by one of the rajahs of Boondee; as also a house or palace belonging to the rajah. Long. 75. 50. E. Lat. 25. 17. N.

PATANY, a port of Asia, on the eastern coast of the peninsula of Malacca, and near the mouth of the Gulf of Siam, situated almost six miles up a river which falls into a bay and forms a good roadstead. It had formerly a considerable trade, which, however, has greatly fallen off. The Chinese now carry on the trade, which consists chiefly in the importation of European goods from Batavia, and the exportation of gold dust, canes, rattans, dragon's blood, &c. Long. 101. 40. E. Lat. 6. 50. N.

PATARA, or PATERA, a town on the sea-coast of Caramania, in Asiatic Turkey. It had in ancient times a celebrated oracle of Apollo, and still retains traces of its ancient grandeur. It is now uninhabited, only a few solitary peasants being seen wandering on the plain. Long. 29. 20. E. Lat. 36. 15. N.

PATATAN, a small town on the north-western coast of Borneo, situated three miles up the river Patatan, which has a smooth and shallow bar. It contains about 100 houses. Long. 116. 5. E. Lat. 5. 50. N.

PATAVINITY (*Patavinitas*), amongst critics, denotes a peculiarity of Livy's diction, derived from *Patavium* or Padua, the place of his nativity; but they are by no means agreed in what this alleged *patavinity* consists. According to Quintilian, Asinius Pollio taxed Livy with patavinity, though what he meant by this censure no one can now say with any certainty. Morhof believes it to consist in a singular turn of expression, and in certain phrases peculiar to the Paduese. All we certainly know about it, however, is, that it was a fault in the language of Livy, not in the sentiments or the manners. In all probability it is one of those delicacies which are no longer perceived or understood in a dead language. In 1685, D. G. Morhof published at Kiel a treatise *De Patavinitate Liviana*, in which he explains, very learnedly, both the urbanity and peregrinity of the Latin language.

PATCHOW Islands, a group of small islands, situated on the coast of China. The easternmost is Typinsan, having on its north side an extensive reef, on which the Providence, Captain Broughton, was wrecked in 1797, in long. 125. 11. E. Lat. 25. 6. N. The southernmost island is in long. 123. 52. E. and lat. 24. 6. N.

PATCOONA, a town of Bengal, and capital of a small district of the same name. It is situated on the northern shore of the Curcurry River, amongst the hills of Pacheet. Long. 87. 2. E. Lat. 23. 3. N.

PATE, in *Fortification*, a kind of platform, resembling in form a horse's shoe.

PATEE, or Pattee, in *Heraldry*, a cross, small in the centre, and widening towards the extremities, which are very broad.

PATERA, amongst antiquaries, a goblet or vessel used by the Romans in their sacrifices, in which they offered their consecrated meats to the gods, and with which they also made libations. The word is Latin, being formed from *pateo*, I am open (*quod pateat*), because it has a great aperture; in contradistinction to bottles and other vessels, which have only narrow necks, or the aperture of which is less than the body of the vessel.

The patera is also an ornament in architecture, which is frequently observed in the Doric frise, and in the tympans of arches. See Architecture.

PATERCULUS, C. Velleius, a Latin historian of considerable celebrity in the reign of Tiberius, is supposed by Dodwell to have been born before Christ 30, and to have been included in the fall of Sejanus, the favourite of Tiberius, a. d. 32. The place of his birth is unknown; but his great-grandfather, Minatius-Magius, was a native of Asculum, and took an active part in favour of the Romans during the Italic war; whilst another of his ancestors, Decius Magius, was of high rank in Campania (Pat. ii. 16). His paternal uncle, Capito, was a senator, and joined with Agrippa in accusing Cassius, the murderer of Cæsar (ii. 69). Paterculus commenced his military career under Caius Cæsar, the grandson of Augustus, and accompanied him to the East as tribune in the second year of the Christian era. On his death he attached himself to the fortunes of Tiberius, and as commander of the cavalry was present during nine years in his several expeditions in Germany, Pannonia, and Dalmatia. On his return to Rome he was raised to the prætorship, a. d. 14, the same year in which Augustus died; but he does not appear to have reached any higher dignity.

Paterculus left an abridgment of Roman history, and had promised a larger work, which it does not appear that he ever executed. This epitome was still in progress, a. d. 30, in the sixteenth year of the reign of Tiberius, and is entitled *Historiæ Romanæ ad M. Vinicium Cos. libri ii.*; but it is incomplete, as the commencement is wanting, and also a portion after the eighth chapter. Only one manuscript has been found of this author, and even that has now disappeared. It was discovered in 1515, by Beatus Rheuanus, in the monastery of Marbach, in Oberelsass, and first published at Basle in 1520. In this work Paterculus intended to give a sketch of the history of the world, more particularly of whatever he thought likely to interest the Romans. He began with the destruction of Troy, and the arrival of Æneas in Italy, and ended with the year 30 of the Christian era. He dwells particularly upon those parts of general history which were connected with that of Rome, and intersperses the work with moral reflections, that do honour to his heart and understanding. In his description of particular characters, he is more than usually happy, though his style is sometimes rather too oratorical, and evinces too much anxiety to strike the imagiation of the reader by startling thoughts and expressions. His language is generally pure, and formed upon the best models of an earlier period. Sallust seems to have been the author whose style he more particularly imitated.

The best editions are those of Burmann, edited by C. H. Frotscher, Leipzig, 1830; and of C. D. Jani and J. C. Krause, Leipzig, 1800.

PATERNO, a city of the island of Sicily, in the intendency of Catania, and district of Demone. It is situated on an inclined plain of Mount Ætna, in an unhealthy situation, near the river Garetta, 120 miles from Palermo. It contains 9880 inhabitants, chiefly employed in cultivation. Near to it are many interesting remains of antiquity.

PATERNOSTERS, Great, a cluster of shoals and islets in the Eastern Seas, which are about 120 miles in length from north-east to south-west, and thirty in breadth. Long. 117. 10. to 119. 10. E. Lat. 6. 30. to 7. 42. S.

Paternosters, *Little*. These consist of about thirteen small rocks in the Eastern Seas, between the islands of Borneo and Celebes. They are covered with trees, and have navigable channels between them; but they are surrounded with numerous shoals very dangerous to mariners.

PATERY, a hilly and woody district of Hindustan, in the province of Berar, and situated on the north bank of the Godavery River, seventy-eight miles south-east from Aurungabad. Long. 77. 8. E. Lat. 19. 18. N.

PATHHEAD, a large well-built village of Scotland, in the parishes of Crichton and Cranstoun, in the county of Mid-Lothian, ten miles and a half from Edinburgh. It consists of one long street, built upon both sides of the road leading to Kelso. The houses are generally of one story, and occupied by those engaged in husbandry, in collieries, and in furnishing the district with those necessaries which cannot be easily supplied from the capital. The population is about 1000. The parish church of Crichton is about two miles distant, and was founded in the year 1449. It is a neat little building, of Gothic architecture, in the form of a cross; and the internal arrangement is also Gothic. Near it is the magnificent ruin of Crichton Castle, which, for beauty of architecture, internal accommodation, and strength of walls and situation, is hardly to be excelled by any of the old baronial castles of Scotland.

Pathhead, a large and populous village in the parish of Dysart, in Fifeshire, Scotland. It is contiguous to the town of Kirkcaldy, being merely separated from it by a steep ascent called the Path. The village consists of three streets of plain substantial houses, inhabited by a most industrious class, who are chiefly engaged in the weaving and manufacturing of linen goods, especially of checks and ticks. There are two places of worship, one belonging to the Established Church, the other to the body of Antiburghers. An elegant and commodious school was erected a few years ago, for the free education of 150 children, by the trustees of the late Robert Philp, Esq. of Kirkcaldy, who left a large sum of money for that purpose. The population in 1831 amounted to 3330.

PATHOGNOMONIC, amongst physicians, an appellation descriptive of a symptom, or concourse of symptoms, inseparable from a distemper, and which are found in that only, and in no other disease.

PATHOLOGY, GENERAL.

The term Pathology, in its widest signification, comprehends all the knowledge which we possess relative to the state of Disease. For the facility of teaching and of studying, it has been found convenient to make various divisions of this extensive science. By the French, the terms of *external* and *internal* pathology have been employed as synonymous with what in this country are denominated the principles and practice of surgery and physic; the purpose of this division obviously being to separate the objects of medical doctrine and practice into two departments, and to assign each of these to a particular class of cultivators and practitioners. Another very important division of pathology which has long been recognised, is that into *special* and *general;* the first, or special pathology, being intended to comprehend the consideration of particular diseases, as they occur in nature; and the second, general pathology, to include, in the first place, the more general facts or principles that have been ascertained relative to the primary elements of diseases, as comprehending the *causes, phenomena,* and *effects* of the various derangements to which the animal economy is subject; and, in the second place, those more general facts or principles relative to the more obvious analogies of diseases, and the natural groups to which they admit of being referred, which medical men have deduced from the comparison of particular diseases with one another. Unlike the division into internal and external, that into special and general makes no partition of the subjects of pathological inquiry; for both survey the whole of these subjects, though under different aspects. General pathology, though in its investigation obviously resting, as we had formerly occasion to show (see article Medicine), upon a knowledge of the special, has, in teaching, been found to form a convenient and appropriate introduction to it; just as, in other sciences, it is convenient to give a general view of the principles which have been established, before entering upon the particular details the knowledge of which has led to the establishment of these principles, but of which details these principles, when once ascertained, very materially facilitate the comprehension and acquisition.

Under whatever point of view we consider the derangements of the human economy, whether, with the clinical physician, we regard them as they present themselves in individual cases, or, with the special pathologist, as constituting particular genera or species of diseases; or whether, with the general pathologist, we endeavour to reduce them to their primary elements; in each case, they offer precisely the same subjects for our investigation. These are, *first,* the morbid phenomena or symptoms by which we become aware that derangements have actually occurred in the economy; *second,* the morbific agents, by which derangements of the economy are liable to be produced; *third,* the more immediate seats of the derangements to which the economy is liable, and the peculiar nature of each of these derangements; and, *fourth,* the morbid alterations discoverable in the dead body, in those who, during life, had exhibited derangements in the performance of their functions, whether these perceptible alterations stand in the relation of cause or of effect to the derangements of function.

It is in the mode of considering these several subjects, therefore, rather than in the subjects themselves, that the distinction between general and special pathology must be looked for. In special pathology, symptoms, morbific agents, proximate causes, and organic lesions, are respectively considered in those combinations in which they give rise to, or occur in, particular diseases; and attention is directed to them only in as far as they are calculated to elucidate the natural history of the particular disease that may be at the time under consideration. In general pathology, on the other hand, the consideration of symptoms, of morbific agents, of proximate causes, and of organic lesions, or those branches of medical science which have been termed symptomatology or semeiotics, ætiology, pathogeny, and morbid anatomy, constitute so many separate portions of pathological doctrine, in which the whole of the subjects falling under each department are methodically arranged, and considered in reference to one another.

Illustration.

It may perhaps tend to place the distinction between general and special pathology in a clearer light, if we endeavour to illustrate it by a particular example.

It not unfrequently happens, that an individual exhibits a combination of *symptoms* of the following kind. He has pain in some part of the chest, his respiration is difficult, and he is subject to cough; and these symptoms, all of them obviously referrible to some derangement in the respiratory organs, are attended with others of a more general character,—with those symptoms which are denominated febrile, that is, with increased frequency of pulse, with increased heat of skin, and with disturbance of several of the other functions of the body. Now the first object of the special pathologist, in respect of this combination of symptoms, is to distinguish it as constituting a particular disease which he terms pneumonia (or inflammation of the lungs), from other combinations of symptoms which may bear a certain degree of resemblance to it,—to establish its *diagnosis,* or distinction from other analogous diseases. And even in the several cases which present the combination of symptoms that has been mentioned, the special pathologist may be able to detect certain differences of character which will lead him to establish more or fewer divisions of his particular disease; differences, for example, in the condition of the pulse, and in the characters of the pain and of the cough. Thus, of the disease in question, nosologists, or those who treat expressly of the divisions, definitions, nomenclature, and arrangement of diseases, have been led to recognise three principal forms, under the names of peripneumony, pleurisy, and bastard peripneumony. The special pathologist, in his consideration of the symptoms of pneumonia, besides distinguishing it from other diseases, and marking the more probable diversities in which it may present itself, traces its characteristic symptoms throughout the whole course of the disease, and marks the diversities which these assume in its different stages, and the other less distinguishing symptoms with which they are accompanied; in short, he applies his knowledge of the morbid phenomena, or symptoms of this disease, to determining its definition, its diagnosis, and its history.

All of those symptoms which have been mentioned as occurring in and characterizing pneumonia, fall under the consideration of the general as well as of the special pathologist; but the view which the former takes of them is considerably different from that which we have just endeavoured to sketch as being taken by the latter. By the general pathologist, these symptoms fall to be considered, not in the combinations in which they present themselves in nature, but each of them as an abstract existence, and in its relations to the other morbid affections of the organ or function of which it indicates the derangement. Thus the general pathologist has occasion to consider the symptom of *quickness of pulse,* in the general view that he takes of the different morbid phenomena which result from derangements of the function of circulation. An opportunity is thus afforded him of conisdering this symptom of increased frequency of pulse, not only in relation to the healthy state of this phenomenon, but in relation also to the other morbid states to which it is subject, whether as regards its frequency, its strength, or its regularity. By studying, in this manner, the morbid conditions of the pulse as a general pathological doctrine, medical men are furnished with a body of information of most important practical application in the investigation, not of one particular disease only, but of many different diseases. The morbid phenomenon or symptom of *cough*, in like manner, is obviously capable of being considered as a particular subject of investigation in reference to the other morbid derangements of function to which the respiratory organs are liable, and particularly in reference to the various modifications which this symptom may itself exhibit.

Secondly, a similar difference may be traced in the manner in which the special and the general pathologist consider the *morbid alterations of structure* that are discoverable in the body after death. In pneumonia these morbid alterations consist of more or less extensive marks of inflammatory action in the contents of the cavity of the chest. The special pathologist considers these morbid alterations in reference to the particular combination of symptoms that characterize pneumonia, or may accompany its progress. He examines into the condition of the contents of the chest, with a view to throw light on the phenomena which the disease exhibits during life, to trace the correspondence of the morbid appearances with the nature, degree, and progress of the external symptoms. The general pathologist likewise has occasion to direct his attention to those morbid alterations of structure to which we have alluded; but, in the view which he takes of the diseased economy, they present themselves to his attention, not, as they do to the special pathologist, in their connection with a particular disease, but as constituting one of the forms of morbid alteration of structure to which the respiratory organs are liable, the whole of which he passes successively in review, simply as a department of the natural history of the economy in its diseased conditions.

Thirdly, when the special pathologist, in endeavouring to discover the *morbific agencies* by the operation of which pneumonia has been excited, is led to ascribe its production to the influence of cold, he pays no further regard to that morbific agent, than in its relation to this particular disease; he considers merely the conditions under which cold must be applied to the economy in order to produce pneumonia, the length of time that intervenes between its application and the appearance of the symptoms, and such other points as bear directly upon the agency of the particular cause in producing the particular effect. By the general pathologist, on the other hand, this morbific agent, cold, falls to be considered as a special subject of investigation, along with the various changes that are liable to occur in the different physical conditions, and particularly in the temperature, of the atmosphere; and not as giving rise to one particular combination of symptoms or disease, but, generally, in its injurious operation on the several functions and organs of the body.

Lastly, as regards the consideration of the *proximate cause* of pneumonia, the special pathologist is led, by a consideration of the symptoms which he has observed during life, of the morbid changes which he has found after death, and of the morbific agent to which he has traced the production of the disease, to conclude that the more immediate seat of derangement is in the substance or in the membranes of the lungs, and that the particular mode in which these parts are affected is that usually termed inflammation. He is contented, therefore, with having detected the proximate cause of pneumonia as being inflammation of the lungs. But the general pathologist, in considering proximate causes as a particular department of inquiry, endeavours to go farther back in the succession of morbid changes, and to ascertain, from an investigation of the circumstances which attend the development of inflammation in different parts of the body, what are the more intimate conditions of the economy to which that morbid state is referrible, in whatever organ or texture it may occur.

Advan. tages o neral p thology

There can, we conceive, be little doubt, that a much more complete and satisfactory view must be obtained of each symptom, morbific agent, proximate cause, and organic lesion, when treated of systematically, in connection with other analogous phenomena, than when noticed incidentally in those varying combinations in which they present themselves to the special pathologist, in tracing and in describing the histories of particular diseases. And if we reflect upon the circumstances under which the several subjects of pathological investigation actually present themselves to the attention of the student of pathology, in the consideration of a particular disease,—morbid functions, morbid structures, morbific agents, and proximate causes of disease, all of them combined in one whole, the relations of the several parts of which it is necessary for him, as if intuitively, to comprehend,—it must be obvious, that unless he shall previously have had an opportunity of taking a systematic view of each of these branches of pathological inquiry by itself, such as is afforded in the study of general pathology, he cannot fail to be lost among the multitudinous and imperfectly understood matters which, simultaneously, as it were, press themselves upon his attention.

The pathologist, indeed, is in a great measure in the same situation as the chemist, who meets in nature, for the most part, with objects which consist, not of one, but of several different elements, and which have been produced and are maintained in their combinations by the action, not of one, but of several different forces. To be able to understand the constitution of such a compound object, and the share which each physical and chemical force has had in its production and maintenance, it is necessary that the chemist should be well acquainted with those elements into which compound bodies are found to be reducible. And he must also be acquainted with those few powers or forces which, by their operation on the several elements of matter, enable it to enter into those multitudinous combinations that give rise to the great diversity of substances of which the globe consists. In short, the special pathologist has to do with particular diseases, the general pathologist with the elements of diseases—elements which can be ascertained only by analytical examination, founded on long-continued observation and experience; but a knowledge of which, when once acquired, is of primary importance in those synthetical operations by which the special pathologist endeavours to arrive at the establishment and distinction of particular diseases.

Topics be not

The limits which we are obliged to prescribe to ourselves in the following article render it impossible to take a satisfactory view of the various subjects which fall under the province of general pathology; and, at the same time, we are unwilling to occupy the pages of this work with a bare enumeration of the topics which, in a systematic consideration of this department of medical science, would properly claim our notice. We shall confine ourselves, therefore, to some general observations relative to the state of disease; the distinctions between this state and that of health; the primary seats of diseased actions or diseased conditions in the animal economy; and the more essential differences existing among those simple pathological states, morbid conditions, or primary elementary derangements in the structure and functions of the different parts of the human economy, on which the series of morbid phenomena constituting particular diseases depend—those states, in short, to which the name of proximate causes of disease has very generally been applied. The topics which we have now enumerated are those the consideration of which is usually included under the branch of general pathology termed *Pathogeny*. A slight view of them, we hope, may be rendered both interesting and instructive to general readers; and, at the same time, will prepare the way for a review of the difficulties to which medical men are exposed in endeavouring to determine, in individual cases, the nature of the maladies with which their patients are affected, which we purpose to sketch in the article Physic, Practice of.

D nitions of sease.

V bal.

The first duty of the pathologist seems obviously to be, to define that which professedly forms the object of his inquiries and speculations, viz. the state of disease. The definitions of this term, which have been proposed by pathologists, have differed, not only in the precise language in which they have been expressed, but in the general principles on which they have been constructed. Some have been merely what are called verbal definitions, that is, substitutions of synonymous expressions; such, for example, is the definition which represents disease as a change from the natural to a preternatural state, natural and preternatural being nothing more than synonymous expressions for healthy and diseased. It is needless to insist on the obvious fact, that no possible benefit can result to medical science from definitions of this kind.

Fr n sup- po final ca

In others of the definitions that have been given of the term disease, an attempt has been made to found this upon the supposed final cause of the phenomena which that state presents. Thus disease has been said by some pathologists, including the illustrious Sydenham, to be an extraordinary effort undertaken by nature, for the purpose of throwing out from the system, by the motions excited, some morbific or noxious matter, and of thereby averting from it death and corruption. The attempt to establish the final cause of any phenomenon obviously implies a persuasion of our being acquainted, as far as the particular object is concerned, with the views and intentions of the Author of nature, in obedience to whose will the universe is conducted. The ends or purposes of some of His arrangements seem sufficiently obvious to justify us in deducing them; but there are others of these arrangements in which this is far from being the case, and in attempting to establish the final causes of which, we run the risk of substituting some crude conception of our own minds for the wisdom of the Creator. That there is great risk of doing so in respect of disease, might easily be established, by the various and even contradictory views of its end or purpose which have been taken by those who have endeavoured to derive their definition of this state from its final cause.

rom sup- ose real sse e.

In a third set of definitions of the term disease, an attempt has been made to explain what has been called its real essence; as when disease has been said to consist in a disproportion of the four humours, or in an excess or deficiency of the principle of excitability. It would be easy to show that the definitions of disease which have been framed upon the principle of explaining its real essence, have varied with the prevailing medical doctrine of the period in which they have been proposed, inasmuch as they have necessarily borne a relation to the views entertained by medical men respecting the powers by which the functions of the human economy are carried on in the state of health, in whichever of the various forms of mechanical, chemical, animistic, or vital doctrines, these powers may have been sought for.

From enumeration of obvious characters.

How, then, is disease to be defined? Precisely, it is conceived, upon the same principles that every other object which admits of definition ought to be defined. By an enumeration of circumstances obvious to all, and acknowledged by all, to appertain to it; an enumeration not depending for its reception on the speculative opinions of the person to whom it is addressed, but recognised as valid, whatever decision we may come to on certain controverted points of physiological or pathological doctrine; whether, for example, we suppose the functions of the animal economy to be executed conformably to, or in a manner subversive of, the physical and chemical laws of inorganized matter; whether we admit or reject the agency of a rational soul, or that of a peculiar principle of life, in regulating its healthy and morbid phenomena; whether we affirm or deny that dynamical derangement must in all instances be preceded by organic alteration; whether or not we suppose mental derangement to be in all cases dependent on corporeal affection; and whether or not we admit that the fluids may be the primary seats of disease. Health and disease must be defined in reference to one another. It is certainly the occurrence of disease that suggests to the mind the idea of health; but this idea is the rule or standard by which we fix our notions of the state of disease. They are both states of living beings; and the respects in which they differ seem to be, that in the state of health living beings maintain their ordinary structure, and are capable of exercising all their functions with ease, regularity, and harmony; whilst in the state of disease there is an obvious change in the structure or organization of some of the solid parts of which the living beings consist, or in the composition of some of their fluids; or there is a considerable deviation from the easy, regular, and harmonious performance of one or more of their functions.

This definition, it is conceived, is applicable to any being, or class of beings, of which health and disease can be predicated. The structure of living beings is more or less complicated, and the functions they perform are more or less numerous, according to the place they hold in the scale of organized existence. Consequently the number of particulars falling within the two terms, health and disease, must vary. In the human subject these terms must be understood as having reference to the exercise of the mental faculties or functions, as well as of the corporeal; but the definitions above suggested are, we conceive, equally applicable to the simplest and to the most complicated of organized beings. The definition which we have given of disease makes provision also for those slighter diversities in the manner in which different persons, or the same persons under different circumstances, exercise their functions, which, though not consistent with perfect health, are still too inconsiderable to amount to absolute disease; diversities which are usually included by pathologists under the term of the latitude of health.

Proximate causes of disease.

Having pointed out the principles which should guide us in the definition of the term disease, and the elements of which that definition should consist, we shall now proceed to offer some general observations on what are called the proximate causes of diseases, or, in other words, those morbid states or pathological conditions of the different portions of the economy to which the morbid phenomena or symptoms of diseases are ultimately referrible. As we had formerly occasion to advert to the relations in which symptoms and proximate causes stand to one another, we shall not at present dwell on this subject farther than to remark, that general readers as well as students of pathology are exceedingly liable to be puzzled by the great variety of synonymous terms which have been employed by different pathologists to designate respectively the proximate causes of diseases, and the concourses of symptoms to which they give rise. Thus Professor Sprengel, in his *Institutiones Medicæ*, iv. 19, with the purpose of marking the distinction between these two distinct constituent parts of disease, has proposed to employ the term "*morbus*," or disease, to denote the internal morbid condition or proximate cause, and the term "*affectio*," affection or passion, to mark the attendant combination of external symptoms. "Whatever," he remarks, "is perceptible by the senses of the patient himself, or of his attendants, is to be considered as the passion or affection, but the internal state is the true disease." By others of the German pathologists, and particularly by Gmelin of Tubingen, and by the late Professor Hartmann of Vienna, it has been proposed to mark the same distinction between the internal morbid states and the external symptoms of diseases, by the employment of the terms *disease*, and *form of disease;* the term disease being applied by them, as it is by Sprengel, to the morbid or pathological condition or conditions of the economy in which particular diseases essentially consist; whilst, by the term form of disease, they wish to designate the combinations of morbid phenomena occurring in concourse and succession which manifest themselves in the progress of particular diseases, and which Sprengel has included, as we have just seen, under the ambiguous and equivocal term of "affectio." Besides the terms to which we have alluded, a considerable variety of other appellations have been employed more particularly to designate the internal morbid conditions of the economy considered as the states on the existence of which, singly or in combination, the phenomena or symptoms of particular diseases depend. For in different pathological works these internal morbid conditions are treated of under the various appellations of primary elements of diseases, primary morbid states or pathological conditions, and of simple morbid affections or simple diseases (morbi simplices). Chomel speaks of them as the essences of diseases; they form the internal morbid conditions of Broussais, the simple affections, the internal alterations, and common principles of diseases, of Buffalini; and the "*internæ indoles morbi*" of Friedlander. Some pathologists have denominated them *pathological*, in contradistinction to *nosological* diseases; the term nosological being applied in the same sense as the "*morbi forma*," or form of disease, of the later German writers, to those combinations of morbid phenomena or symptoms occurring in concourse and succession, by which particular diseases are externally manifested and are characterized in our systems of nosology.

May comprehend a succession of events.

In speaking of the proximate cause of any disease, it is necessary to keep in recollection, that under this title may be comprehended everything that goes on in the economy between the application to it, or action upon it, of the morbific agent which disturbs its physiological or healthy condition, and the manifest derangement of function which results. Frequently the change from the healthy to the morbid state does not consist in a single event, but in a succession of events. Thus, when the effect of a blow inflicted upon the head is to induce the concourse of symptoms that are comprehended under the nosological disease apoplexy, the first effect may have been the rupture of an artery within the cranium; as a consequence of this rupture there occurs an extravasation of blood; and, as a consequence of this extravasation, a particular state of the brain, whether or not we may admit it to be of the nature of compression. We may regard all this series of events combined, as constituting the proximate cause of the apoplectic attack; or we may restrict this term either to the last event in the series which we are able to trace as preceding the production of the symptoms, or to the event or change which first succeeds to the operation of the morbific cause.

Seats of proximate causes.

A curious topic of inquiry relative to those primary morbid states or pathological conditions which constitute the proximate causes of diseases, relates to their seats, or the parts of the economy in which the changes from the healthy to the morbid condition, on which the production of morbid phenomena or symptoms depends, may occur.

Organic and dynamic.

We formerly noticed the division of proximate causes into the organic or structural, and the dynamic or functional (article Medicine). This is a division as to the propriety of which much disputation has taken place amongst pathologists. If it were to be understood as drawing an absolute line between pathological states arising out of altered conditions of the organic structure of the different textures, systems, and organs of the body, and pathological states arising out of altered conditions of the properties or powers by which the functions are executed, independently of any altered conditions of the organic structure, the distinction would obviously be fallacious. The properties or powers by which the functions of the body at least are performed, have no existence independently of its material organization. And accordingly we cannot conceive any change to occur in the condition of these properties, without its being preceded by a corresponding change in the condition of the material organization. The proper signification to be attached to the terms organic and dynamic proximate causes seems, therefore, to be, that in the former there occurs an *apparent* alteration in the structure of some part of the frame; whilst in the latter, no alteration of structure is *discoverable*, the change in the condition of the material organization being of too subtile a nature to be appreciable by the senses.

Corporeal and mental.

The next question relative to the seats of the proximate causes of diseases that presents itself for consideration is, whether, when the mental functions betray evidence of a deranged performance, this is to be considered as having its primary origin in morbid conditions of the mind itself, or in changes, perceptible or imperceptible, in the material organization. It is allowed on all hands, that it is by no means infrequent, in cases of mental derangement, to find marks of organic alteration of structure in the brain, whilst in other cases no such appearances are discoverable. Of these dissimilar, not to say contradictory results, those who contend for and those who oppose the dependence of mental derangements on morbid conditions of the material organization are equally prepared to give explanations. Those who oppose this dependence aver that when morbid appearances are present, they are to be regarded as concurrent effects of the condition which produces the symptoms of mental aberration, and not as the causes of the mental disturbance; and hold that the independence of mental upon bodily derangements is proved by those cases in which all appearance of organic alteration is wanting. The pathologists who contend for this dependence allege, on the other hand, that whatever may be thought of the morbid appearances observable in the first class of cases, it is quite possible to conceive respecting the second, that changes in the material organization actually exist, although they are of too subtile a nature to be discovered; in short, that mental derangements may be dependent on dynamical and not on structural alterations of the material organization.

Setting aside, then, as inconclusive, the arguments deduced on either side from the results of anatomical investigations, the opposed partisans appeal to the morbific agents by which mental derangements are liable to be induced, and to the means by which their removal is best promoted, for corroboration of their respective views. The advocates for the independence of the mind refer to cases in which mental derangement has been produced or removed by moral or purely mental causes; whilst the advocates for its dependence allege that almost every morbid affection of the mind succeeds to the action of certain physical and vital causes, which can be supposed to operate on the mind only through the intervention of the organization, and particularly of the brain; and they enforce the importance of attention to the state of the corporeal organs in the treatment of insanity. This contrariety of opinion obviously rests on the opposite views that have been propounded relative to the connection of the mind and the body in the state of health; a subject into which we feel indisposed here to enter, not from the apprehension that any conclusion at which we could arrive regarding it would be inconsistent with that belief in the future existence of the soul which forms the groundwork of all religion, but from a conviction that it is a question to the solution of which the human faculties are incompetent.

There is still another question relative to the seats of the proximate causes of diseases, which it is necessary for the general pathologist to consider and determine, viz. it being admitted that the different fluids of the body are liable to morbid alterations in their physical and chemical qualities, whether such morbid conditions of the fluids are capable of constituting in themselves real proximate causes of diseases; or, in other words, whether the fluids are ever the seats of those morbid conditions or pathological states on which the external phenomena or symptoms of diseases depend.

Against the supposition of morbid conditions of the fluids ever being the proximate causes of diseases, it has been argued, first, that the morbid alterations to which they are liable depend on previously existing morbid conditions of the solids, and are to be regarded in the light of effects rather than as causes. When, for example, the secretion of the kidneys contains some of its ordinary constituents in undue proportion, or contains an element not usually found in it, this morbid condition of the urine, it is urged, must be supposed to depend on a previous morbid condition of the kidneys. To estimate the force of this argument, it is necessary to consider the fluids of the body as belonging to two classes; first, the blood, and the fluids out of which it is formed, the chyme and chyle; and, second, the fluids formed out of the blood, including the various secretions, as the saliva, the bile, the urine, &c. Now, without any morbid action of the organs of digestion, and merely in consequence of the introduction of unsuitable food into the stomach, we may suppose the chyme and chyle, and consequently the blood into which they are converted, to be vitiated. Again, in passing through the lungs, the blood may be acted on in such a way as to produce important changes in its physical and chemical constitution, by elements contained in the inspired air, and independently of any morbid condition of the solids. The blood being vitiated in either of the ways supposed, or in others that might be mentioned, the fluids secreted from it may be conceived to participate in its noxious qualities likewise, without any previous morbid condition of the solids. But if, on the other hand, the blood be in a healthy state, and the fluids formed from it be diseased, we must suppose this to depend on some morbid condition of the secretory organ, whether of a structural or dynamical character. From this view it appears that morbid states of the fluids, though they in some instances proceed from morbid conditions of the solids, in others occur independently of any such conditions.

But it has been argued, secondly, that when there exists any noxious principle in the fluids, and particularly in the blood, whether preceded or not preceded by morbid conditions of the solids, it is not immediately on the altered state of the blood, but on a change which it induces in the solid parts, that any morbid phenomena or symptoms which manifest themselves depend; that the blood serves merely as a vehicle for bringing certain noxious agents in contact with those parts on which they most readily exert their action; so that the blood, when it has undergone any morbid alteration, ought to be regarded rather in the light of a remote or occasional, than as a proximate cause of disease. Thus, for example, when, in consequence of extirpation or disease of the kidneys, urea accumulates in the blood, this acts as a poison upon the nervous system. Here, it is said, the blood can only be regarded as a vehicle of the urea, which acts as a morbific agent upon the brain; and it is in the brain that the change takes place which constitutes the proximate cause of the comatose affection that succeeds.

In this argument a fact seems to be overlooked, to which we formerly adverted, viz. that between the first action of a morbific agent upon some part of the economy, and the manifestation of those phenomena or symptoms which ultimately result, there usually occurs a *succession* of morbid changes. Is the term proximate cause to be understood as embracing the whole of these changes, or as being confined to one only? and if to one, does it apply to the first change which we can detect as being produced in the economy, or to the last of the series which we are able to trace, as immediately producing the development of the symptoms? If we include the whole series of changes under the term proximate cause, then morbid states of the fluids must, we conceive, be admitted as forming a constituent element of some proximate causes. Or if we restrict the term to the change in the economy that is first produced, then we must admit that this occurs frequently in the states of the fluids. So that it could only be by restricting the term proximate cause to the last change which we are able to trace in the economy, previously to the manifestation of the symptoms, that we could be supposed justified in denying that morbid conditions of the fluids act occasionally as the proximate causes of diseases.

The question, whether preternatural conditions of the fluids, and of the blood in particular, can be regarded as capable of constituting the proximate causes of diseases, or indeed are themselves entitled to the appellations of morbid or diseased states, has been supposed to depend on the judgment that may be formed relative to the vitality of the fluids, or their possession of life; it being argued, that unless endowed with life, they cannot be subjects of disease. There seems to us to be great fallacy in this argument. We cannot concur in the physiological doctrine which would represent life as a peculiar property, with which certain bodies are endowed; nor are we any more disposed to regard it as a single definite result. The phenomena of the human economy are no more effected by the agency of a single property, power, or force, than are those of a steam-ship; and it would, in our estimation, be as reasonable to suppose that the admission of a *principle of propulsion* is necessary and sufficient for the explanation of the latter class of phenomena, as that the former can be explained by the assumption of a *principle of life.* The propulsion in the one case, and the life in the other, are the effects of the conjunct operation of several properties or powers, and do not constitute in themselves either simple powers or simple results. The expression of the life being in the blood, seems to be obviously a metaphorical expression, of the same character as would be a poet's invocation to steam as the principle of propulsion.

We shall now proceed to take a summary view of the different forms of morbid states, pathological conditions or proximate causes, from the existence and operation of which severally, or more or fewer in conjunction, in the different parts of the human economy, the various concourses of symptoms, or nosological diseases, to which that economy is subject, seem to originate. We shall, in the first place, pass in review organic or structural proximate causes, or, in other words, the visible morbid changes that are discoverable in the physical and structural conditions of the different textures, systems, organs, and cavities of the body.

Organic proximate causes.

The greater degree of attention that is now bestowed on the examination after death, of the morbid changes which are liable to take place in the structure of the different parts of the body, must be regarded as one of the circumstances that most strikingly distinguish the medical investigations of the present period from those of former times. Indeed, the result of these investigations has been the creation of an entirely new branch of medical science, designated by the name of pathological anatomy, a branch the knowledge of which is every day becoming more and more important, from the discoveries that are continually making in it, and from the light these discoveries have a tendency to throw upon the phenomena, the nature, the effects, and the treatment of diseases. It may justly, indeed, be said, that it is to the zeal and success with which morbid anatomy has been cultivated during the last half century, that we principally owe the recent rapid progress and advancement of pathological knowledge, and much of all that is most solid and exact in medicine considered as a science.

Pathological anatomy has been said by the late Professor Lobstein, in his work on that subject, to have three objects to accomplish. In the first place, it describes the changes which occur, in regard to the position, form, size, and intimate structure of each organ in the state of disease, and considers every such organ in its relations to the other parts with which it is connected by more or less immediate sympathies. The second object of pathological anatomy is to explain, as far as this may be possible, the morbid changes that occur in different organs; to point out the manner in which these changes are effected; and to ascertain under what influences, and according to what laws, they are produced. These inquiries comprehend all questions relative to the origin, formation, and development, of organic diseases. In the third place, it is the province of pathological anatomy to compare organic alterations with the morbid phenomena or symptoms that manifest themselves during the course of a disease, to analyse these phenomena with care, and to determine to what degree they are dependent on the alterations of structure by which they are accompanied.

It is in the second of these points of view only that we have occasion at present to consider this department of medical science, as elucidating the origin, formation, and development of the various visible structural alterations which occur in the different organs of the body. As the morbid changes of structure that are liable to occur in different parts of the body are all referrible to a certain number of specific elementary forms, which exhibit the same general characters, in whatever textures or organs they may be seated, great advantage is derived from studying these elementary forms of morbid alterations of structure abstractedly, before proceeding to consider them as they are observed to occur in the particular organs of the body. This view of the elementary forms of diseased alterations of structure might, perhaps, without impropriety, be considered as forming a branch of pathogeny, the more peculiar province of morbid anatomy being, as we conceive, to consider, what Professor Lobstein has marked out as its first object, the primary morbid changes as taking place in the structure of each of the different textures, systems, and organs of the body individually.

The morbid changes of structure that occur in the different textures and organs of the body may be temporary, disappearing after a longer or shorter period of time, and leaving the parts which they attack in their original healthy condition. Hence it is that in many diseases not of a fatal nature, it is only from death occurring accidentally during their continuance, or in a short time after their termination, that we have an opportunity of ascertaining the morbid changes of structure by which they are accompanied. In other instances, again, the morbid changes are of a more permanent nature, and when the disease in the course of which they arise does not prove fatal, they may either continue to exist without materially disturbing the economy, or they may prove the cause of new diseases.

Pneumatosis.

The first physical change in the condition of the body to which we shall allude, as giving rise to morbid phenomena or symptoms, is the presence of air in situations in which it does not naturally exist, or its excessive accumulation in situations in which it is usually met with. This occurrence it has been proposed to designate by the name of Pneumatosis. The presence of air in the subcutaneous cellular substance, sometimes occurring as a consequence of injury, and in other instances independently of injury, has been long known to surgeons by the name of emphysema. In the sacs of the pleuræ, a quantity of air occasionally collects, producing great disturbance of respiration, an occurrence to which the name of pneumo- or pneumatothorax has in recent times been applied. It is well known, too, that in some cases of sudden death occurring during surgical operations, air has been found in the cavity of the heart. In the cavity of the alimentary canal there is always present a quantity of air or gas, but under certain circumstances the quantity becomes greatly augmented, giving rise to the state of the abdomen termed by medical men tympanites. It belongs to the general pathologist to ascertain the different seats in which a preternatural accumulation of gases is liable to occur, and their chemical characters in these various situations; and to endeavour to determine the sources from which, in each situation, they may be supposed to have been derived; whether the particular form of pneumatosis under observation has depended on the introduction of atmospheric air by natural or accidental passages; on the putrefactive decomposition of solid or fluid substances; on mechanical obstruction to the free passage of gases in parts which naturally contain them; on the perforation of organs naturally containing gases, and the consequent escape of these into other parts; or whether a gas is ever exhaled from the surface of a cavity or canal in the human body in consequence of diseased action.

Anæmia.

A second change that sometimes presents itself to those engaged in tracing the pathological conditions of the body, and one which, according to its particular seat, may give rise to the symptoms of various diseases, is a deficiency of blood either in the vascular system generally (in which case its most obvious indications are to be found in a peculiar paleness of the face, and particularly of the lips and of the gums), or in the vessels of some particular textures or organs. To this state medical men give the name of anæmia, or bloodlessness. It belongs to the general pathologist to inquire into the various situations in which anæmia is liable to be met with; and into the circumstances in which it may be supposed to originate, whether from absolute deficiency, or from vitiated qualities of the nutritious fluid.

Congestion.

A third morbid condition, which gives rise to symptoms of much importance and of considerable variety according to the particular seat which it may occupy, is the reverse of that last mentioned, consisting in a turgescence of the whole, or of particular portions of the vascular system. This is the morbid condition which medical men have denominated congestion, and to which the terms active or passive are affixed, according as it is supposed to depend on an increased propulsion of blood into a particular texture or organ, by the powers which maintain the circulation; or on an obstruction, which prevents the blood that has been sent to a part in due quantity, from being returned with proper freedom to the heart. When the state of vascular turgescence is general, in consequence of an excessive production of blood, the vascular system is said to be in a state of plethora; so that plethora is general congestion, and congestion is partial plethora. When the blood is sent to some particular part of the body in increased quantity, without the morbid condition of inflammation being produced, or, in other words, when there occurs active local congestion, English pathologists apply to this morbid state the name of determination, and French pathologists that of fluxion. It forms by no means an unimportant object of pathological inquiry, to determine the characters by which local congestion occurring during life may be distinguished, in the examination of dead bodies, from similar appearances originating during the agony of death, or subsequently to that event, principally in obedience to the laws of dead matter.

Another morbid condition, and one nearly allied to congestion, is that in which the contents of the sanguiferous system escape from the vessels in which they circulate, and are discharged either on the surface of a cavity or canal, or into the substance of an organ. This constitutes the state termed hæmorrhage. We have examples of hæmorrhage occurring on the surface of a cavity or canal in the discharge of blood from the lungs, termed hæmoptysis by medical men, or from the stomach in hæmatemesis; and of hæmorrhage occurring into the substance of an organ we have examples in many cases of apoplexy, in which a larger or smaller quantity of blood is discharged into the substance of the brain. Like congestion, hæmorrhage may be active or passive, that is to say, it may depend either on the blood being propelled into a particular texture or organ in greater quantity or with more force than is usual, or on some obstruction to its return to the heart. To that state of the sanguiferous system on which active hæmorrhage depends, pathologists give the name of the *molimen hæmorrhagicum.* It belongs to the general pathologist to inquire into the various seats in which hæmorrhage is liable to occur; the conditions of the blood, and of the blood-vessels on which it may be supposed to depend; the modes in which the blood escapes from the vessels in cases in which no visible solutions of continuity can be detected; whether this takes place by dilatation of open terminations of blood-vessels, or what is usually called sanguineous exhalation; or whether by dilatation of pores in their coats, a theory of hæmorrhage which is intended to be expressed by the terms sanguineous transudation. The changes which extravasated blood produces on the surrounding tissues, and those which it itself undergoes in various situations subsequently to its being extravasated, constitute inquiries of very considerable importance to the pathologist, particularly the question, whether, in any instances, extravasated blood is capable of becoming organized.

In the state of health there occurs an effusion of a watery fluid into the cellular texture lying beneath the skin, or entering into the composition of parenchymatous organs, and into those cavities of the body which are lined by serous membranes; but the removal of this fluid by absorption seems to go on as rapidly as its secretion, so that the quantity never becomes considerable. In disease, however, an accumulation of watery or serous fluid is liable to occur in the various situations that have been mentioned, producing a pathological state which has long been known to pathologists, under the name of dropsy, as a fertile source of morbid phenomena. It has been supposed that an accumulation of serous fluid occurring in disease, might depend either on the secretion being increased without a proportionate increase in the power of absorption, or on a diminished power of absorption not attended with a corresponding diminution in the power of secretion. It is well ascertained, that in a large proportion of the cases in which dropsical effusion occurs, there exists, as in passive congestion, an impediment to the free return of the blood to the heart. Such, for example, seems to be the case in those organic diseases in the course of which dropsy is so apt to supervene, such as the organic diseases of the liver, or of the heart itself. An impediment to the capillary or venous circulation does not however appear to be essential to the production of dropsy. In certain inflammatory conditions of the membranes by which serum is naturally secreted, dropsical effusion is liable to take place, constituting what may be called inflammatory or active dropsy; and it would appear from modern investigations, that in certain diseased conditions of the kidneys, dropsy occurs, without there being any reason to suspect mechanical impediment to the capillary or venous circulation. Under certain circumstances, an effusion of a serous fluid takes place from membranes of a mucous character; but in this case the fluid, instead of accumulating in the body as in serous dropsy, is discharged externally.

Inflammation.

There is no morbid state to which the economy is liable, of greater importance, in respect of the number of diseases of which it serves as the foundation or which it complicates in their progress, or in respect of the severity of these diseases, and the frequency of their occurrence, than that of inflammation. Every thing combines to prove that it is in the capillary vessels that this morbid state has its immediate seat; but much diversity of opinion subsists among pathologists as to the precise condition of these vessels, in respect of increased or diminished action, in the state of inflammation. From its frequent occurrence on the surface of the body, as in inflammation of the skin or of the eye, the phenomena of inflammation are more generally known to non-professional readers, than those of any other morbid condition to which the body is subject. But the pathologist is aware that these phenomena undergo very considerable modifications, according to the texture in which the inflammation may happen to occur.

The state of inflammation sometimes disappears entirely from an organ or texture that has been affected by it, leaving in them no trace of its having existed. In this case it is said to undergo resolution. Sometimes, again, it becomes associated with, or leaves behind it, various morbid conditions, which have been denominated the terminations, local effects, or consequences of inflammation. Of these terminations, some manifest themselves in the effusion either of an increased quantity of the fluids that are naturally secreted, or in the formation of preternatural fluids from surfaces, or into the substance of organs. When boiling water, or a blister, is applied to the skin, the scarf-skin, in a longer or shorter time, rises in vesications; and if it be pierced, a quantity of watery fluid exudes. This is an illustration of inflammation terminating in an effusion of serum. If a part of the body be removed by a cutting instrument, and after a short time the surface thus produced be examined, it will be found to be covered by a glutinous fluid. Again, if a fluid be injected into the cavity of the abdomen, the serous membrane which lines that cavity, and covers the intestines, will in no great length of time be found coated with a similar glutinous matter. These are examples of the termination of inflammation in effusion of coagulable lymph; an occurrence, as we shall presently see, of equal importance, whether we regard its salutary or its noxious effects in the economy. Every one knows, more or less, what is meant by an abscess, viz. a collection of what is called purulent matter in some texture or organ of the body. The effusion of purulent matter, whether into the substance of an organ or texture, or on the surface of a membrane, is uniformly preceded by inflammation, and constitutes what is denominated its suppurative process, or termination in suppuration.

In many instances, the state of inflammation is followed by the removal or disappearance of a larger or smaller portion of the substance of the body, in consequence of a morbid absorption. We have illustrations of such a morbid absorption, first, in the formation of ulcers on the surface of the body; this may be called *ulcerative* absorption: second, in that process by which an abscess that may be seated at a considerable depth from the surface of the body, gradually approaches towards it, and at last is discharged externally; in which and similar cases, the absorption is said to be *progressive*: and, third, in the mode in which parts of the body that have become dead are separated from the living, or what has been called *disjunctive* absorption.

The death of a part is another event which is liable to occur as a termination of inflammation, particularly when very intense in its character. This state has been variously designated. By applying to the whole progress of this consequence of inflammation, from its commencement to its conclusion, the name of mortification, pathologists are enabled to mark out two important stages, the first extending to the period when the mortified part loses its vitality, which stage has been named gangrene; and the second designating the state in which the part is perfectly dead, the stage or state of sphacelus.

As some of the terminations of inflammation are destructive, so others of them are reparatory. We have already noticed the effusion of coagulable lymph as being frequently of this character. If the two surfaces of an incised wound covered with coagulable lymph be brought into apposition, they will adhere, and in a short time become united by the passage of blood-vessels from one surface to the other. This is called the termination of inflammation in adhesion. But if the surfaces of a wound be not brought into apposition, the layer of coagulable lymph effused upon them will in a short time exhibit a number of granular eminences, which acquire a bright red colour, from their becoming penetrated with blood-vessels. To this process is given the name of granulation. In a longer or shorter time, the granular surface becomes covered with a bluish-white layer, and being considerably diminished in extent by its own contraction and the elongation of the surrounding integuments, it comes to be again skinned over, or, in the language of surgeons, it undergoes cicatrization. Similar processes take place in the interior parts of the body. Should a person on the serous surface of whose bowels an effusion of coagulable lymph has taken place, survive the violence of the inflammatory attack, the lymph, in becoming organized, will produce adhesion of the different folds of intestines to one another, and to the inner surface of the walls of the abdomen; and an ulcer on the inner surface of the stomach or intestinal canal may undergo the processes of granulation and cicatrization, just in the same way as an ulcer on the skin.

Alterations of consistence.

In the progress of the various inflammatory processes which we have enumerated, the different textures and organs in which they occur are liable to undergo alterations in their consistence, becoming in some cases harder, and in other instances softer, than natural. There seems reason to believe, however, that these changes of induration and softening sometimes occur in particular organs or textures, independently of any inflammatory action, and simply from morbidly increased interstitial deposition, or morbidly increased interstitial absorption. Much attention, for example, has recently been paid to a state of softening occurring in the brain, in cases in which there is no reason to believe it to have been connected with inflammation. A peculiar softening of the coats of the stomach, first particularly noticed by Mr John Hunter, and attributed by him to the solvent action of the gastric juice after death, has been supposed by some pathologists to be a product of disease, taking place during life, and characterized by a peculiar concourse and succession of symptoms. As softening is a change liable to occur in the putrefactive decomposition which the different parts of the body undergo after death, considerable care is requisite to avoid confounding pseudo-morbid with truly morbid softening of the textures.

Alteration in amount of substance.

The different textures and organs of the body sometimes undergo an alteration in the amount of their natural substance, capable of modifying very considerably the exercise of their functions, and consequently of constituting the proximate causes of diseases. Sometimes the substance of the texture or organ is in excess, in which case it is said to be in a state of hypertrophy. In other instances there occurs a diminution in the amount of substance, or what has been called atrophy, or, more properly, perhaps, oligotrophy. Every one is aware how much the bulk of the voluntary muscles depends upon the degree of exercise to which they are subjected. A similar principle is applicable to the involuntary muscles; and accordingly it is found, that when by any cause impeding the free motion of the blood in either circulation, the action of one or other ventricle of the heart requires to be performed with increased vigour, it takes on the state of hypertrophy. The same change is liable to occur in the urinary bladder when there exists a mechanical impediment to the discharge of its contents. Under certain circumstances, one of the kidneys becomes incapable of effecting its natural secretion. In this case, the bulk of the organ very frequently diminishes, or, in other words, the kidney passes into a state of atrophy; whilst its neighbour, taking upon itself, as it were, the duties of both, becomes enlarged in bulk, or passes into a state of hypertrophy. The only explanation we are able to give of the production of this class of organic changes is, that the nutritive vessels of the texture or organ which experiences them act with increased or with diminished vigour.

New formations.

In a large number of cases of morbid alteration occurring in the different textures and organs of the body, there is found replacing more or less of their natural substance, or disseminated through it, a substance of a nature entirely foreign to it. Sometimes this new or foreign substance resembles more or less closely one of the natural textures of the body, as when a mass of fat, or portions of cartilage or of bone, are formed in situations which they do not naturally occupy. To such productions of natural textures in preternatural situations the name of homoioplastic formations has been applied. In other instances, the new formations consist of substances altogether foreign to the natural organization of the body, as when masses of hard or of soft cancer (the *scirrhus* and *fungus hæmatodes* of pathologists) are developed in one of the various situations in which they may occur. Such formations receive the general denomination of heteroplastic. Various other divisions have been made by pathologists, of the different new growths to which the textures, systems, and organs of the body are subject, according as they are symptomatic or idiopathic, cystic or sarcomatous, &c.; but that which is perhaps of most practical importance is, their division into the mild and the malignant. The latter of these terms is applied to such new growths as manifest more or fewer of the following characters; first, that at no period of their development are they susceptible of resolution, that is, of being removed by natural processes of the economy; second, that they are very apt to appear in different textures and organs of the body simultaneously, or in succession; and, third, that when they are removed by operation, growths of the same character are very apt to recur in the same situation, or to develope themselves in some part not previously affected. It is obvious, that in the production both of the homoioplastic and of the heteroplastic formations, the nutritive vessels of the part must be supposed to secrete a matter different from that which they habitually furnish; with this distinction, that in the first class the secreted matter is analogous to that which the same vessels in the state of health furnish to other textures, whilst in the second, the matters are totally different from those formed in any part of the economy in a healthy condition.

Homoioplastic.

Heteroplastic.

Entozoa.

The morbid products that have hitherto been mentioned as occurring in the different parts of the body, are either inorganized, as in the cases of pneumatosis, dropsy, and some of the new growths; or, if organized, it is by a vascular communication with the body in which they exist. But it sometimes happens that separate living beings are met with in different textures and organs, constituting what by naturalists are termed entozoa. The entozoa most familiarly known are intestinal worms, which, as every one is aware, give rise to a great variety of morbid phenomena or symptoms. Sometimes the entozoon, instead of having the general characters of a worm, consists of a nearly transparent bag filled with serous fluid, in which case it is termed an hydatid. The disease occurring in sheep, named the sturdy in some parts of this country, depends on the existence of hydatids in the brain; and entozoa of the same generic character have now been found in the substance of almost every organ and tissue of the human body, and even in the fluids contained in the transparent cavities of the eyeball. Entozoa are different from any species of animals that are found *out of* living bodies; and nothing is more perplexing to naturalists than to explain the manner in which they are produced and propagated. It has been ascertained that some genera and species of entozoa are confined to particular animals, whilst others are distributed pretty widely over the animal kingdom.

Co cre- tio .

It sometimes happens that a secreted fluid deposits a portion of the solid matter which it contains, and this by accumulation comes to form one or more masses of various dimensions, which may either remain in the situation in which they were first formed, or may make their way into other situations. These masses, of which we have examples in the depositions that occur from the urine, from the bile, from the saliva, and sometimes even from the tears, are called concretions, calculi, or stones, by pathologists. A singular form of concretion is not unfrequently met with in certain veins of the body, particularly the uterine and pelvic, to which, from their position, the name of phlebolites has been given. In these several instances, we may suppose the deposition to have depended either on a deficient quantity of the dissolving menstruum in which the solid matters were contained, or on an excess of the saline, &c. ingredients; or it may in some cases have depended on the presence of a foreign ingredient in the fluid, producing precipitation of some of its natural principles. In the alimentary canal, concretions are occasionally formed by an agglutination of matter introduced along with the food, and the viscid secretions of the mucous surface of the stomach or intestines. Thus it has been found, that in those districts in which oatmeal forms a large portion of the diet of the labouring classes, such concretions are liable to be formed by the inner beards of the oats; and an excessive employment of magnesia as an antacid medicine has been known to produce an analogous result. In horses, alvine concretions, formed chiefly out of their food, sometimes attain a very large size; and in those animals which are in the habit of licking with their tongues their own hides, or those of their young, balls of hair, curiously fashioned, are very frequently met with.

Alte ions of ca city.

Sometimes the several hollow organs of the body, without any appearance of change in the textures of which they consist, are found to have undergone an alteration in their capacity, which may either extend over a considerable portion, or be limited to a single point. In some instances the cavities or canals referred to are more capacious than natural, or in a state of dilatation; in other instances they are less capacious than natural, or in a state of contraction; and sometimes contraction occurring in the course of a canal may approach, if not amount, to obliteration. Contraction, as occurring in a canal, constitutes simple organic stricture. It not unfrequently happens that the states of contraction and dilatation are met with in different parts of the same organ; for if a portion of the alimentary canal, for example, become contracted, so as to retard the passage of its contents through it, the portion above the contraction will be very liable to become dilated by distention. The arteries are liable to undergo two different forms of dilatation, the one consisting in a preternatural and permanent enlargement of the whole circle of the canal, the other in a partial or lateral distention of its coats. To a dilatation of the second kind the name of an aneurismal sac is given by pathologists, and much controversy has existed as to the conditions of the coats of the vessels in which it is formed. Permanent dilatation of the veins, produced by the accumulation of blood in their cavities, constitutes what has been called varix. In some instances contraction at a particular portion of a canal, or stricture, seems to be congenital. Of this there is a curious illustration in a contraction that has been repeatedly met with in the aorta, or great artery of the systemic circulation, at a very short distance from its origin in the heart. Congenital stricture, sometimes amounting to obliteration, is not unfrequently met with at the lower extremity of the intestinal canal.

Dila ion.

Cont - tion d oblite - ion.

Alterations in position.

Very serious morbid phenomena occasionally result from textures or organs having undergone changes in their natural position. Thus it sometimes happens that a portion of the lining membrane of the gullet is protruded between the layers of muscular fibres which surround it, and in this way a pouch or bag is produced, which may occasion great impediment to deglutition. Again, it sometimes happens that a portion of the intestinal canal slips down, as it were, into the portion immediately below it, forming an *invagination*, as it is termed, and causing, so long as it lasts, more or less obstruction of the bowels; or a portion of bowel may escape from within the cavity of the abdomen, through an aperture, natural or preternatural, in its parietes, constituting what surgeons term a *rupture*, or *hernia*, and requiring, in many instances, the performance of a delicate surgical operation for its replacement or *reduction*. To alterations in the relative position of the parts constituting a joint, viz. the socket, and the lever which moves upon it as a fulcrum, surgeons, as is well known, give the name of *dislocations*.

Malformations.

Lastly, morbid phenomena are found to be referrible, in some cases, not to any structural alterations occurring in the progress of life, but to imperfections in the original organization of the individual,—to what are called malformations or monstrosities. These imperfections or malformations seem sometimes to consist in the absence or incomplete development of a particular organ or set of organs, as if the natural process of development had been arrested or retarded during the early stages of the growth of the fœtus. In other instances they consist in reduplication of one or more of the parts of the body; and in others, again, the process of development seems to have taken a perverted or vicious direction, so as to produce anomalies not referrible to either of the two heads that have just been mentioned. Of malformations compatible with life, but laying a foundation for disease, we have examples in certain conditions of the heart, and large vessels immediately connected with it, which allow a portion of the blood to pass from the right side of the heart to the left, without passing through the lungs, and consequently without undergoing that depuratory process which it is the purpose of respiration to effect. In this case the extremities of the fingers, the lips, and other external parts of the body, have more or less of a blue colour, giving rise to the affection denominated cyanosis, or blue disease.

Such seem to be the principal sensible alterations that are liable to occur in the animal frame, and which, as giving origin to various combinations of morbid phenomena or symptoms, we regard as proximate causes of diseases.

Dynamic proximate causes.

We have, in the next place, to consider those proximate causes of disease, pathological states, or morbid conditions, which are not attended with any sensible alterations in the textures or organs of the body, recognisable during life or after death; and the occurrence of which is inferred solely from the disturbance that takes place in the exercise of particular functions. Thus, under certain circumstances, the action of the heart may become irregular, and yet after a time resume its wonted regularity, showing that no *organic* alteration had occurred in it; or this fact may be still more decidedly established, in case of accidental death, by the actual inspection of the parts. The secretion of the kidneys may, in like manner, be very materially altered in respect of its quantity or composition, without these organs having undergone any discoverable change in their anatomical constitution. In our inability to refer such derangements of function to perceptible organic changes, we attribute them to changes or alterations in the peculiar powers, forces, or principles, with which the parts are endowed, that enter into the composition of the texture or organ the function of which is deranged; and it is in this respect that these derangements are properly termed *dynamical.*

In judging of the *structural* changes which disease is liable to induce in the several textures, systems, and organs of the body, it is obviously of primary importance that we should be well acquainted with their healthy structure and appearances, and with the changes which these are liable to undergo subsequently to death, from putrefactive decomposition, and other causes. The more extensive and accurate our knowledge of these matters becomes, the better must we be qualified to recognise the presence of structural alterations, and to determine in what they actually consist. In like manner, in considering the *dynamical* derangements which are liable to occur in the human economy, it is essential to have determined what powers are concerned in the production of its various healthy phenomena. The full consideration of this subject obviously falls under the province of the physiologist; but as it is one respecting which considerable confusion of ideas seems to us to prevail, and the correct determination of which is not less important to the pathologist than to the physiologist, we shall venture to offer a few remarks with regard to it.

In entering on this inquiry, it is necessary to keep in mind, that all the phenomena of the human economy, as far as they are corporeal, are produced by the reciprocal action of certain external agents, and of the different parts of the organized frame, upon one another. It is necessary also to keep in mind, that all which is meant by ascribing to any substance the possession of a particular property, is, that when a certain other substance is present, a particular change will take place in the condition of one or other, or of both of them. In stricter language, we substitute the term *susceptibility* for that of property, in those cases in which the change is most obvious in the substance to which we ascribe the property; and we use the term *power* in those cases in which the change is most obvious in the substance that is brought into relation with that to which we ascribe the property. It is equally a property of water to be solidified by a certain degree of cold, and to dissolve salt; but, in accurate expression, susceptibility is applicable to water in respect of the former, and power in respect of the latter, of these phenomena. When the pathologist, therefore, speaks of derangements or diseased conditions of the *powers* or *properties* of the human economy, as contrasted with morbid conditions of the structure of the body, he does not mean to allege that changes have taken place in certain mysterious agencies or spirits lurking in certain textures of the body; but he means that changes not recognisable by our senses have occurred in these textures, in consequence of which they differently affect, or are differently affected by, external agents, from what is habitual to them. It is of these differences in the mode of affecting and of being affected that we, by observation, obtain a knowledge; and it is by reasoning back from these that we infer the occurrence of those changes in the conditions of the particular textures of the animal frame, of which, in the application to them of the term dynamical, we avow that we cannot obtain any more direct information.

Understanding the term power in this signification, we may remark, that it is not peculiar to organic textures to undergo changes in their powers or properties, without any perceptible change of their interior physical conditions. When a bar of iron, on being struck with a hammer, is rendered magnetic, or deprived of its magnetic power, according to the direction in which it is previously placed (see the article MAGNETISM), no change can be detected in the characters of the mass, or of the particles of which it consists. The only knowledge we obtain of any change having taken place in the bar of iron, is derived from its evincing or not evincing magnetic properties.

What, then, are the properties concerned in the production of the various phenomena of the human economy, so far as these are of a corporeal nature?

The learned and the unlearned all concur in recognising a particular class of beings under the title of living or organized, and in distinguishing this from another class of beings, which they designate as inorganized, lifeless, or dead. There is likewise a pretty general concurrence in acknowledging that the prominent characters or outstanding phenomena by which living beings are distinguished from those that are dead, are, *first,* the conversion of foreign matters into their own substance, which is continually going on within them; and, *second,* their invariably taking their origin from a part which had previously belonged to another being of exactly the same nature with themselves. For accomplishing these two ends (the processes of assimilation and reproduction, as they are termed), it is found that certain determinate series of phenomena are executed by living beings, to which the name of vital or organic functions is assigned, such as the functions of circulation, of respiration, of secretion, &c. The question, therefore, as to the properties concerned in producing the various corporeal phenomena of the human economy, resolves itself into the inquiry, what powers or agencies are concerned in the execution of each of these vital functions? Are the phenomena of which each of them consists, and which, as has been said, result from the reciprocal action of external agents, and of the different parts of the body, on one another, when analysed and separately examined, of the same nature as the phenomena observed to occur in the inorganized world; or are they of a nature specifically distinct from these; or is there a correspondence in some and a diversity in others? It is on the determination of these questions, obviously, that our judgment must be founded, how far it is necessary to attribute to the different parts of the body powers, principles, or properties, distinct from those of inorganized matter, or, shortly speaking, vital or organic properties, since such properties, if recognised, can be considered only as general expressions for determinate groups of phenomena, identical in themselves, and different from any which can be observed to occur in the inorganized world.

And here we may remark, that, in modern times particularly, there has very generally prevailed among physiologists a great disinclination to admit an identity in the various phenomena of living beings and resembling phenomena of inorganic matter; or, in other words, to admit the operation, in the production of the phenomena of living beings, of those physical and chemical properties to which the various mutations that dead matter is liable to undergo are usually ascribed. Accordingly, physiologists very generally maintain that the agencies by which the characteristic phenomena of living beings are produced, are essentially different from those on which the phenomena of inorganic matter depend. It is not denied that there is a general correspondence in the material phenomena exhibited by the two classes of beings; that in each of them there is evidence of the occurrence both of motions in the sensible masses, and motions in the insensible elements, of matter, —of both physical and chemical changes. But there is a great disposition to allege, that notwithstanding this general correspondence, there exist such special differences between the physical and chemical phenomena of organized and of inorganized bodies, as to render it necessary to admit the operation, in the production of the former, of powers or properties distinct from those which operate in producing the latter; that vital physics and vital chemistry are distinct sciences from inorganic physics and inorganic chemistry, acknowledging different and even contradictory laws. Before proceeding to consider what grounds actually exist for this strong disinclination to recognise the operation in the animal economy of the physical and chemical properties of inorganic matter, we may remark, that it may probably be traced in a great measure to two sources, *first*, the abuse of physical and chemical explanations of the phenomena of the animal economy which was practised by the mathematical and the chemical sects of physicians; and, *second*, the wish which the cultivators of any branch of knowledge generally entertain to establish for it an independent character. It is not impossible that, in the present instance, this latter feeling may be increased by the pride of man rendering him averse to recognise an identity, even in his corporeal operations, with those of brute matter.

The opinions of physiologists respecting the operation in the corporeal functions of the human economy, of powers different from those which regulate the changes of inorganic matter, may perhaps be advantageously reduced to the three following heads.

1*st*, That all the phenomena of this economy are under the guidance of a single property, by whatever name this may be designated, which is capable of subverting, and indeed is in a perpetual struggle with, the physical and chemical laws of inorganic matter.

2*d*, That each function of the economy is under the guidance of a particular or special principle; and,

3*d*, That in certain animal textures, independently of, or superadded to, the physical and chemical powers of inorganic matter, there are implanted powers specifically distinct from these, which have an important share in the production of most or of all the phenomena of the animal economy.

To the two first of these doctrines there present themselves objections of precisely the same nature. They confound complex with simple results; and refer to the agency of a common power, a number of phenomena which, though they may be considered as all tending to a common end, are widely different in their essential nature from one another. The function of respiration, for example, comprehends a number of distinct phenomena, some physical and some chemical, understanding by these terms respectively the motions of the sensible masses and of the insensible elements of matter; and to suppose that science can be advanced by attributing all this variety of phenomena to the agency of a common principle, is a strange deviation from the ordinary laws of philosophical inquiry. If this observation be just in regard to one function, it must certainly acquire additional force the greater the number of functions, and consequently the greater the diversity of phenomena, the production of which is referred to the agency of the supposed principle.

The advocates of the third doctrine recognise the important influence of those physical and chemical powers to which the phenomena of inorganic matter are attributed, in producing the phenomena of the several functions of the animal economy, so far as these are corporeal. But an analysis of these functions leads them to believe that, besides the inorganic powers, there must be others concerned in their production, seeing that some of their phenomena are of a nature specifically distinct from those exhibited by any form of dead matter. They do not content themselves with the general conclusion that the function of digestion, for example, is totally different from any process which occurs in inorganic beings, and that it is consequently incumbent upon us to admit the existence of a peculiar vital principle of digestion; but analysing, as far as they are able, the various phenomena which, in combination and succession, constitute this function,—tracing the series of antecedents and consequents by which it is effected,—they endeavour to determine what are the precise phenomena which do, and what are those which do not, admit of being referred to the ordinary properties of inorganic matter, and are thus led to judge what phenomena, from not being referrible to these properties, require the recognition of powers peculiar to living beings in general, or to the animal economy in particular.

There are obviously two sources of error in the judgments which may be formed on these points. 1*st*, Our imperfect knowledge of the phenomena respecting which we are called on to judge; our inability to trace the successive series of changes by which the obvious result is ultimately effected. How much of the knowledge requisite for enabling us to refer the phenomena of digestion, to resume our former example, to their respective causes, is of very recent attainment? how much perhaps still remains to be acquired? But, 2*d*, our knowledge of the laws which preside over the physical and chemical changes of inorganic matter is likewise still very imperfect. There are doubtless very many phenomena going on in the inorganic world, which have not even been observed, far less generalized. These may have their resembling phenomena in the economy of living beings; and, from our ignorance of the one, we may fail to observe the other; or, in observing them, we may erroneously suppose them to depend on principles or properties peculiar to the economy in which they present themselves to our notice. The observations and experiments of Mr Brown respecting the motions of molecular particles, those of Dutrochet relative to Endosmosis and Exosmosis, and those of Professor Graham relative to the transmission of gases, have brought to light in our own days a number of phenomena occurring in the inorganic world, which may very possibly have their resemblances in the economy of organized beings; and other sources of motion and change in inorganic matter may yet remain to be discovered. And even in respect of those physical and chemical agencies, with the operation of which, in the inorganic kingdom, we are more or less familiar, it is quite possible that they may be taking a share in producing the phenomena of organized beings, though we do not recognise their operation. Thus a very strong belief has been entertained by many physiologists that electricity or galvanism exerts a very important influence in the performance of several of the functions of the animal economy; and that, in like manner, as this economy possesses within itself the power of generating *heat*, so it is provided with an apparatus capable of evolving electricity or galvanism. It is not necessary to enter here into a consideration of the circumstances which have led to the belief that the brain is such an apparatus, and the nerves the conductors of the electrical or galvanic fluid. But we may suggest, that if this opinion could be proved to be correct, many of those phenomena which seem at present irreconcileable with the ordinary properties of inorganic matter, and consequently to require the recognition of peculiar vital powers, might find their explanation in the agency of this powerful source of physical and chemical changes.

If these views relative to the powers concerned in producing the phenomena of living economies be correct, it follows, that it is the duty of the pathologist, in tracing the dynamical derangements to which the different parts of the animal frame are subject, to keep in mind the variations which may occur in the ordinary physical and chemical properties of the solids and fluids of which that frame consists, as well as in those properties which are peculiar to itself; seeing that modifications of these inorganic principles must necessarily have great influence in inducing pathological phenomena.

With this caution we shall now proceed to consider what are the ultimate or simple phenomena occurring in the animal economy, which seem to be specifically different from phenomena observable in the inorganic kingdom, and to require the recognition of peculiar vital properties, and to what pathological conditions these properties seem to be subject. The vital properties most usually recognised by physiologists and pathologists seem to be Irritability, Tonicity, Sensibility, Nervous Energy or Innervation, Sympathy, and Vital Affinity.

Muscular irritability.

Whatever differences may exist in the views which physiologists entertain respecting the other agencies by which the various functions of the animal economy are executed, they universally agree in admitting muscular irritability, or the power which muscular fibres possess of shortening on the application of certain agents, which physiologists term *stimuli*, as a property of great influence in the production of the physical motions observable in the economy, and as one to which nothing strictly analogous, so far as is known, has been discovered in any other portions of nature's works. There are few, indeed, if any, of the corporeal functions of the animal economy, natural, vital, or animal, in the exercise of which muscular fibres, and the principle of irritability with which they have been endowed, are not more or less immediately concerned. And, consequently, the dynamical morbid conditions of these fibres, or the morbid conditions of the principle of irritability, enter largely into the explanations which the pathologist endeavours to give of the derangements to which the different organs of the body are liable in the exercise of their functions.

Its morbid conditions.

The deviations from healthy action to which the principle of irritability is subject, seem referrible to three principal heads, viz. *first*, increased, *second*, diminished, and, *third*, perverted or vitiated action.

Excessive or deficient, in facility;

In respect of irritability, physiologists distinguish between the *facility* and the *force* with which muscular fibres contract, or the *mobility* and *vigour*; and the same distinction must be kept sight of in pathology. Irritability may be excessive in *facility*, or, in other words, muscular fibres may be excessively *mobile*, a slight stimulus producing a contraction to which it would have been quite inadequate in health; or irritability may be deficient in *facility*, or muscular fibres preternaturally *immobile* or *torpid*, a stimulus which would have called a muscle into action in the state of health being now insufficient to effect this. Of preternatural mobility of muscular fibres we have an example in the readiness with which, in particular states of disease, the muscular coats of certain canals, as the gullet and urethra, are excited to contraction by the introduction into these canals of foreign bodies which, in their healthy state, would pass through them without exciting any perceptible muscular contraction. Of preternatural immobility or torpidity, throughout all its possible degrees, we have examples in the state of palsy, both in the voluntary muscles and in involuntary muscular organs.

in force;

Again, irritability may be excessive in *force*, a given amount of stimulus producing a more forcible contraction than in health; as frequently happens to the voluntary muscles in cases of mania, when the patient manifests a degree of physical strength greatly beyond his natural powers; and as seems to occur in respect of the action of the vascular system on the circulating blood, in what is called the phlogistic or inflammatory diathesis. Irritability may likewise be deficient in force, as is well known to happen to the voluntary muscular system in some diseases, as fevers at a very early stage of their progress, and as happens in all diseases, sooner or later, in the course of their progress. Of deficient force of irritability in involuntary muscular organs, we have an example in the action of the sanguiferous system in the state of collapse, or sinking.

It may be remarked, that the states of diminished force or vigour, and increased facility or mobility of contraction, are frequently combined in the same muscles or muscular organs; so that although a small amount of stimulus is sufficient to call them into action, their action is not powerful. This fact is often exemplified in the contractions of the heart, which may be very frequent in number, and at the same time very feeble in force.

Vitiated.

Besides increased and diminished force and facility of action, there are other morbid conditions to which the power of muscular irritability is liable, that may be referred to the head of altered or vitiated action. In the ordinary circumstances of the economy, the contraction of a muscle, succeeding to the application of a stimulus, is speedily followed by a state of relaxation, and this even though the stimulus which produced the contraction continues to be applied.

Spasm.

But there is a morbid state of the contraction of muscles that is not disposed spontaneously to alternate with relaxation, and in which, too, the fibres do not easily yield to any extending powers that may be applied. Such a state of contraction, which may occur either in voluntary muscles, or in involuntary muscular organs, is called a state of spasm. Most persons have had experience of those local spasms which, under various circumstances, occur in the muscles of the extremities, particularly of the calves of the legs, and to which the name of cramps is familiarly given. That singular affection which has been termed catalepsy, in which a part of the body retains for a great length of time the position in which it may be placed, however disagreeable or fatiguing it might be to the person when in health, furnishes us with an example of a tendency to spasmodic contraction pervading the whole of the voluntary system of muscles. The various muscular canals, as the gullet, the intestines, the gall-ducts, the urethra, &c. are frequently the seat of spasmodic affection, producing an inorganic form of *stricture*.

Convulsion.

A second morbid condition of irritability that may be referred to the head of vitiated or altered action, is that in which muscles and muscular organs are excited to contraction by preternatural causes, and are contracted with unusual velocity and force, and in which, especially, the contractions alternating with relaxation are frequently and preternaturally repeated. Contractions of this kind are observable in the greater part of the muscles of voluntary motion, in the fits or paroxysms of the disease termed epilepsy; and to the same class belong the agitatory motions observable in different parts of the body in chorea, or St Vitus's dance, and in hysteria. These contractions have sometimes been called *clonic* spasms, whilst the epithet of *tonic* spasms has been applied to contractions not alternated with relaxations. But the terms tonic and clonic spasms are now very generally laid aside by pathologists, and the two different kinds of muscular contraction formerly designated by them are now usually distinguished from one another by the simple names of spasms and convulsions. Though spasm and convulsion be in themselves distinct phenomena, it would be easy, by a reference to particular diseases, to illustrate the truth of Dr Cullen's remark, that "many, and indeed most, of the diseases considered as spasmodic affections, are, in respect of tonic and clonic contractions, of a mixed kind." (Sect. 1753.)

Vl expility.

A wide difference of opinion has subsisted among physiologists as to the nature of the power by which the relaxation of a muscle succeeding to its contraction, consequent on the application of a stimulus, is effected; some conceiving that a sufficient explanation of this phenomenon is to be found in the simple elasticity of muscular substance, whilst others maintain that it can be accounted for only by recognising in muscles an active power of expansion as well as of contraction. Nor is it muscular tissue only which has been supposed to be endowed with an active principle of expansion or dilatation. By many the expansion which is liable to occur under peculiar circumstances, in what has been called the erectile tissue, is supposed to have its primary origin in an active distention of that tissue itself, and not in its mere passive dilatation by fluids propelled into it from behind, or accumulating in it in consequence of obstruction to their further course (Chaussier, Adelon, Stieglitz, &c.): whilst by others it is conceived, that to explain the state of *orgasm*, as it is called, we must pre-suppose the existence of an increased vital affinity between the blood and the tissue of the organ which is capable of distention (Müller). The phenomena in question are certainly highly deserving of investigation; but we confess we are not at present prepared to acknowledge the necessity of admitting a peculiar vital property as being concerned in their production.

Tocity.

Many physiologists have admitted the existence in the animal economy of another form of contractile power besides irritability, distinct from any observable in inorganic matter, to which they have given the name of tonicity. There has been great vagueness, however, in the attempts which have been made to define the peculiar characters of this property, so as to distinguish it from the elasticity of inorganic matter on the one hand, and from muscular irritability on the other, as well as to determine by what textures it is possessed.

Supsed pro of its exince.

Many phenomena seem to prove, that in living and healthy animals, the muscular fibres, both of the voluntary muscles, and of involuntary muscular organs, have a constant tendency to become shorter, and, but for counterbalancing powers, such as antagonist muscles or distending liquids, would actually become so. Thus, if any joint be bent by external force, the flexor muscles contract spontaneously without any exertion of the will. If a muscle be divided transversely by the knife of the surgeon, a considerable degree of retraction takes place in the separated portions, and the antagonist muscle also contracts. That the retraction in this latter case is not attributable to the stimulus of the knife, appears from the fact, that "the separate portions which have been retracted," as Mr Mayo remarks, "if excited, shorten further, and then again become elongated to their last dimension." Besides, when the tendon of a living muscle is cut across, the muscle instantly contracts, and continues of its diminished length. In fracture of the patella, the rectus muscle of the thigh contracts sometimes to a very great extent; and in most cases of fracture there occurs similar retraction, which, though it may be in part explicable by the irritation of splintered pieces of bone, cannot be wholly attributed to that cause. It is found, also, that the arteries are always nearly accommodated to the quantity of blood contained in them. When a ligature is placed upon an artery of a living animal, the part of the artery beyond the ligature becomes gradually smaller, and is emptied to a certain degree, if not completely, of the blood it contained. It has been observed, too, that some hours after death the arteries are much diminished in size, and this occasionally to such an extent as to be rendered impervious.

By some physiologists it has been imagined that these phenomena may be explained on the principle of simple elasticity, it being conceived that in the living body muscles are stretched out or extended beyond their natural state as dead elastic substances. "To the elastic nature of the muscles generally," says Dr Bostock (*Elem. Syst. of Physiology*, i. 160–1), "as consisting of a compound of fibre and membrane, I should refer the *natural contraction* of Whytt, those actions which Cullen, and many physiologists since his time, have called tone or tonicity, and which Bichat has classed under the head of contractility from texture, in which, after a part has been distended by any cause, when the distending force is withdrawn, it gradually recovers its natural form and dimensions." But the supposition that muscles are stretched, in the living body, beyond their natural elasticity, is opposed by the fact, that when a dead muscle is cut out of the body, before it has begun to putrefy it will be found to extend farther than from its origin to its insertion, as is particularly evident in a long muscle, such as the sartorius.

There are other circumstances, too, which seem to show that this constant tendency of muscular fibres to contract depends on their connection with the nervous system, on a constant and regular action of the nervous system on the muscular, a fact which does not seem reconcileable with the notion of its being simple elasticity. When the portio dura (or muscular nerve) of one side of the face is divided, the muscles of the opposite side of the face contract to such a degree as to draw the cheek of the affected side over to it; and the same thing is liable to occur as a consequence of cerebral apoplexy. It is usual to explain this phenomenon by saying that the muscles of the affected cheek, having lost their tonicity, no longer counterbalance those of the sound side, which, in consequence, being left to the uncontrolled influence of their own tonicity, undergo contraction; nor does there appear to be any mode of accounting for it, either on the hypothesis of simple elasticity or of irritability. We may perhaps also regard the pathological condition of relaxation of the sphincter muscles occurring in particular states of the nervous system, as evidence of the dependence of tonicity upon that system. It is proper, however, to keep in mind a fact which seems to have been ascertained by Bichat, viz. that when a muscle is transversely divided, the retraction is equally prompt and energetic, whether the nerves of the part have been previously cut through or not.

If, then, we recognise irritable contractility and tonic contractility, or irritability and tonicity, as two distinct vital properties, the following seem to be the characters by which they must be distinguished from one another: *First*, tonicity is the tendency which certain parts of the animal frame have to contract, independently of the agency of stimuli; irritability is the tendency of muscular fibres to contract in consequence of the agency of stimuli: *second*, the contractions dependent on irritability are alternated with relaxation; those dependent on tonicity are not so alternated. As a *third* distinctive character, it has been alleged that while the contractions of irritability are instantaneous, those arising from tonicity are very gradual and slow.

Application to pathology.

While the existence of tonicity as a separate power has been a matter of considerable doubt and discussion to physiologists, the language that has been used by pathologists would seem to imply that they were fully persuaded of its existence and very extensive operation in the animal economy; for there is no explanation of morbid phenomena more familiarly in use with the learned or the unlearned, than that of ascribing them to loss of tone, or the state of atony. And, certainly, no class of remedies enjoys a higher degree of popularity than those which, under the designation of tonics, are supposed to possess the power of restoring or increasing the tone of the several organs of the economy, and particularly of the digestive. In examining these expressions with any degree of accuracy, however, we shall find that all which is in general meant to be implied by the use of the term tone, whether applied to the economy generally, or to particular parts of it, is merely vigour of action, without any consideration being paid to the question, whether this depends on a single and peculiar power, or is the result of the combined operation of several distinct powers.

Even in regard of the voluntary muscles, it may be a matter of no small difficulty to decide, when a particular class of muscles are in a state of preternatural contraction, whether this depends on what we have called *spasmodic* irritable contraction of their own fibres, overcoming the resistance of their antagonists, or on their *tonic* contraction, consequent on a loss of tone on the part of their antagonists. In wry-neck, for example, is the primary affection, so far as the muscles are concerned, in those on the side towards which, or in those on the side from which, the head is turned? or may it in some instances depend on one of these causes, and in other instances upon the other cause, affording what Dr Good has designated the two varieties of loxia *irritata*, or spastic wry-neck, from excess of muscular action on the contracted side; and loxia *atonica*, or atonic wry-neck, from direct atony of the muscles on the yielding side?

In involuntary muscular organs, however, it must be a matter of infinitely greater difficulty to trace the influence of pathological conditions of the property of tonicity, in consequence of the more concealed and more limited field of its operations. One of the pathological phenomena occurring in an organic function which seems most to favour the hypothesis of tonicity as a distinct power from irritability, is the state of the arteries in inflammation. Notwithstanding the increased velocity with which, in some cases at least, the small or capillary arteries of an inflamed part propel their contents, they are in a state of distention. Dr Thomson, in his experiments on the effects produced by applying various substances to the web of the frog's foot, found that the state of the capillary vessels thus excited that bore the greatest resemblance, in outward appearance, to the state of inflammation, was that which occurred on the application of a saturated solution of common salt. In this case, the arteries, instead of being contracted, as he found to happen when ammonia is applied, were actually and sensibly dilated. "The part of the web to which the salt was applied became of a red colour, and this redness, which was visible to the naked eye, lasted in general for a period of from three to five or more minutes. It was impossible to view with the naked eye the part to which the salt had been applied, without conceiving it to be inflamed." As in some cases the application of the salt produced an increased velocity in the circulation through the dilated larger and smaller arteries and capillary vessels to which it was more immediately applied, the vascular distention, obviously, could not be attributable to mechanical obstruction.

Whether the distended state of the capillary arteries in inflammation, a state which, it thus appears, can be so readily imitated, if not induced, by the action of salt upon the web of the frog's foot, be attributable to a loss of tone in their parietes, seems a question fairly open for the consideration of pathologists. The idea seems to receive countenance from an interesting observation of Dr Alison's, who found that when, subsequently to death, an artery going to an inflamed limb is compared with the corresponding artery going to an uninflamed limb, it is of larger calibre, and possesses less power of re-acting upon a distending fluid. (*Edin. Med. and Surg. Journ.* xlv. 98.)

On the whole, it may, we believe, without injustice be affirmed that, to determine the propriety of recognising such a peculiar vital property as tonicity at all, and, in the event of its recognition being found necessary, to ascertain the particular phenomena, physiological and pathological, which ought to be referred to its agency, would require a much more precise method of analytical investigation than has ever yet been brought to bear on the elucidation of this subject.

Sensib

The next vital property which we have to mention as generally recognised by physiologists, is sensibility. As voluntary motion consists of an affection of the mind succeeded by an affection of certain parts of the organic frame, viz. the voluntary muscles; so sensation consists of an affection of certain parts of the organic frame, viz. the organs of sense, succeeded by an affection of the mind. In both cases we have reason to believe that the nerves are the media of communication between the brain as the organ of the mind and the other parts of the body. In speaking of sensibility as a vital property, it is necessary to keep in mind the twofold character of sensation, as a corporeal and as a mental phenomenon. We presume that those agents the application of which to certain parts of the body is ultimately followed by those states of mind which we designate sensations, produce some change in the state of the nervous extremities, and that some corresponding changes subsequently ensue in the nervous cords, and ultimately in the brain; just as we presume that, in voluntary motion, the affection of the mind acts in some way on the brain, and that the change induced in this organ is propagated along the nerves to the muscular fibres.

Although the property of irritability is liable to be called into play in a large class of muscles, by the particular state of mind termed the will or volition, yet, in the assistance which it gives in effecting a number of the functions of the animal economy the mind has no share, these functions being purely corporeal. Different names have been given to the irritability of muscular fibres, according as it is called into operation by one or other of these causes, viz. the will or material stimuli, and amongst these the names of animal and organic contractility. Some physiologists have conceived that a similar distinction may be established in respect of sensibility; that, besides what is called animal sensibility, or that property of the nervous system in virtue of which impressions produced on particular parts of the body by external agents, or by peculiar conditions of its own textures, are communicated through the brain to the mind, there is an organic sensibility, in virtue of which the different textures themselves become sensible of the action upon them of external agents; "la faculté," says M. Cailliot, "qu'ont les parties des corps animés de récevoir des impressions quelconques, qui produisent des changemens proportionnés à ces impressions." So completely independent of mind did Bichat, the great advocate of organic sensibility, consider this property to be, that he ascribes it to vegetables. "Nature," says he, "has endowed each portion of a vegetable with the faculty of feeling the impression of the fluids with which the fibres are in contact." (*Anat. Génér.* i. xli.) But if this application of the term sensibility be legitimate, we do not see how it can be confined to the phenomena of organic beings. A piece of marble may with equal propriety be said to be sensible of the impression of the acid which resolves it into its constituent elements; and a detonating powder sensible of the impression of the blow which occasions its explosion. The word sensibility, which is intended to denote a peculiar form of susceptibility, a form the essential peculiarity of which consists in its terminating in the production of a particular state of mind, would in this way be rendered synonymous with susceptibility in general. It is probable that the idea of an organic sensibility may arise in part from the belief entertained by physiologists, that, in many instances, external agents, in acting upon our corporeal organs, do not act upon them directly, but through the intervention of the nerves, the same channels by which sensible impressions are conveyed to the brain as the organ of the mind. But even this point of analogy, if fully established, would not warrant us in connecting the name of sensibility with a phenomenon with which the mind is in no way related.

It orbid co itions.

In respect of sensibility, we know that, independently of any perceptible alterations in the organization of the several parts concerned in the exercise of that function (from that part upon which the impression is primarily made, to that by which it is transferred as it were to the mind, so as to become an object of consciousness), morbid variations are liable to occur, both as regards the intensity of the sensations produced by a given amount of impression, and as regards the qualities of the sensations. Under a variety of circumstances more or less perfectly understood by us, our sensations (both those depending on the impression of external objects, and those which result from processes going on within the body, or our sensations of impression and of consciousness, according to the distinction recognised by Dr Cullen) are liable to become more intense than they are in the state of health. In other circumstances, these sensations, particularly those of impression, become less distinct than natural, or are not at all produced; a state variously designated by nosologists, according to the seat which it may occupy, but which, from its frequent coincidence with diminished muscular irritability, has often been improperly included under the term of paralysis or palsy.

In xcess.

In efici- en

Pe erted.

The various morbid conditions of sensibility which cannot be referred to the two heads of increased and diminished, and which are therefore included under that of vitiated or perverted, seem referrible to the three following: 1*st*, The perception of objects that do not exist, as when those appearances which have been called *muscæ volitantes* are seen floating in the air like dark or luminous spots, lucid ribbons, &c.; 2*d*, the perception of external objects otherwise than they really are or appear to others, whether as respects their number, form, size, colour, or state of motion or rest; and, 3*d*, the perception of the qualities of bodies different from what is usual to us, as when those substances which in health are agreeable to us, become disagreeable, or the reverse.

When these various conditions of sensibility occur as dynamical affections, it is by no means easy for the pathologist in all instances to ascertain in what portion of the nervous system the dynamical affection has its more immediate seat; whether in the extremities of the nerves on which the impression is first received, or in the nervous cords by which it is conducted to the brain, or in the brain itself, in which we presume that some change must be produced previously to the affection of the mind which completes the function of sensation. When, for example, the sense of sight is lost, as in amaurosis, and no perceptible change of structure can be discovered capable of explaining the morbid phenomenon, are we to seek for the seat of the dynamical affection in the retina, in the optic nerve, or in the part of the cerebral mass with which that nerve is more immediately connected?

Supp ed iden y of irrita lity and s si- bility

Before passing from the consideration of the properties of irritability and sensibility, we may observe, that nothing can mark more strongly the extreme difficulty which exists in obtaining the general recognition of the clearest and best established truths of science, than the frequent proposals that have been made, since the differences in the characters of these two vital, or, more correctly speaking, animal properties, irritability and sensibility, were fully demonstrated by Haller, to re-unite them as one property under a common denomination, such as that of excitability, &c. That there is a coincidence in some of their laws, may be admitted; so is there in some of the laws of heat and light, which, too, frequently occur in combination. But the physiologist has no stronger reason for alleging identity in the one case, than the natural philosopher for alleging it in the other; and nothing, we are persuaded, can be conceived more calculated than this confusion to retard the progress of medical science. It has frequently, indeed, been argued in favour of this identity, that irritability implies sensibility; that everything which is irritable must be sensible, in order that it may perceive the stimulus which calls it into action. But, as has been already shown in speaking of organic sensibility, we might as well say that every thing which is inflammable must be sensible, in order that it may perceive the impression of heat; that gunpowder must be sensible of the spark which inflames it.

Nervous energy.

A strong belief has existed among medical men that the several organs of the body are greatly dependent, for the suitable exercise of their functions, on an influence or energy communicated to them by the different parts of the nervous system; some organs being supposed to be more immediately under the control of its cerebro-spinal, and others under that of its ganglionic portion.

This belief has had its origin in the interruption to the exercise of the different functions which has been found to be occasioned by division of the nerves of their respective organs, or by the removal or destruction of particular portions of the nervous system, as well as in the functional derangements that are observed to occur under the influence of diseases of that system, or under the operation of certain agents, such as opium, upon it.

Mode of operation.

But though the facts that have been alluded to seem to warrant the general inference that the central portions of the nervous system exercise, through the medium of the nervous cords, an important influence on the performance of the several organic functions, as well as of those in which consciousness is involved, it must be confessed that we are still unable, from the results of physiological experiments, numerous as these have been, or of pathological observations, to say in what particular manner this influence is brought to bear upon the organic functions, and in what manner it operates. Those who recognise the operation, in the animal economy, of a peculiar principle, to which, from its source, the name of innervation has been given, are not able to say whether it produces or concurs in producing phenomena of a physical or of a chemical character; whether its mode of operation be the same in all the different functions, as the notion of its being a special agent or principle would lead us to conclude, or peculiar in each. Thus, for example, physiologists have very generally concurred in admitting that an influence derived from the nervous system is essential to the performance of the function of digestion, seeing that the division of the par vagum, or the destruction of particular portions of the brain or spinal marrow, put a stop to its continuance. But there is very far from being a like concurrence of opinion as to the particular process or part in the performance of this function, with which that nervous influence is more immediately connected, and the interruption of which causes the discontinuance of the whole function; whether the nervous influence be essential to the conveyance of blood to those secreting organs by which the fluids of the stomach are elaborated; or whether it assists these secreting organs in the performance of their task; or whether it aids in those reciprocal chemical actions which take place between the gastric fluids and the food introduced into the stomach; or whether, by maintaining the peristaltic motion of the stomach, it contributes to the physical removal of the portion of food that has been acted on by the gastric juices, and to the bringing of a new surface of the food in contact with them; or, lastly, whether it may not be that several or all of these successive phenomena of the function of digestion depend on the influence which the stomach derives from the central portions of the nervous system, the ganglionic as well as the cerebro-spinal, through the nerves which ramify in its parietes.

Supposed identity with galvanism.

At one time there seemed reason to believe that physiologists had ascertained the nature of the influence communicated by the nervous system to the several organs of the body—and were thus put in a fair train for ascertaining its mode of operation. When it was found that the interruption to the process of digestion, occasioned by the division of the par vagum, could be obviated by connecting the lower extremity of the nerve with a galvanic battery, or even by allowing its divided extremities to approach within a small distance of one another, it was scarcely possible to resist the conclusion, that galvanism was the active principle essential to the exercise of digestion, of which the division of its nerves deprived the stomach. More recent observations, however, have suggested doubts as to the correctness of this conclusion, and threaten to deprive us of the simple solution of the problem of innervation which it seemed to afford.

Some physiologists, indeed, doubt altogether the production in the central portion of the nervous system, and propagation along the nervous cords, of an energetic power or principle aiding the several organs in the exercise of their particular functional phenomena; and conceive, that in respect of the organic functions the nervous system acts as a medium of communication between their organs and the stimuli or impressions by which they are called into action. According to this hypothesis the food introduced into the stomach produces a particular impression on the extremities of the gastric nerves, which is propagated along the nervous cords to the nervous centres, and the nervous centres being in some way affected by the impression, react, through the same medium of communication, upon the organs in which a change is to be produced; as, for example, upon those which secrete the gastric fluids, or upon those which effect the peristaltic motion of the stomach. If this can be proved to be the correct explanation of the manner in which the nervous system operates in promoting the performance of the organic functions, it may be right to employ some appropriate term to designate it; but, for the reasons already assigned, we must avoid giving to this intervention of the nerves the denomination of sensibility, even with such a qualifying appellation as *organic*.

Application to pathology.

With the physiological doctrine of innervation in a state of so much embarrassment and uncertainty, it cannot be expected that in pathology it should be possible to make any very precise or extensive application of it to the explanation of morbid phenomena. It is obvious, however, that many of the facts on which the doctrine of innervation rests are of a pathological nature. And it is by availing himself of the experiments which nature as it were performs to his hand,—by noting, in cases of organic diseases of the different portions of the nervous system, the changes which occur in the action of the several organs,—that the pathologist may hope to contribute his share to the elucidation of this difficult subject.

In recognising variations in the condition of this vital power, as a probable source of morbid derangements in the exercise of the functions, the pathologist must be careful not to give to this source of morbid actions an overwhelming preponderance, to the exclusion of variations in the other powers, inorganic or organic, that are concerned in the production of the various phenomena of the animal economy. With some pathologists, dynamical derangement of function and innervatory derangement seem to be regarded as synonymous expressions, as if, whenever an organ, in which no structural alteration is discoverable, performs its function in an irregular manner, this must depend on some disturbance of its innervatory influence. But this is by no means the case. Of the three conditions of the economy, for example, described by M. Andral, in which palpitation of the heart is liable to occur, independently of organic lesion, viz. a state of plethora, a state of anemia, and a state unattended with either of these conditions of the vascular system, it is in the last only, in which we conclude that the nervous centres are themselves affected, that we are entitled to attribute the palpitation of the heart to a *lesion of innervation.*

From the nature of the connection which subsists between the nervous system and the several organs of the body, it follows that a *dynamical* affection of an organ,—that is to say, a morbid exercise of its function, unattended with any perceptible alteration in its own structure,—may depend on an *organic* affection of some distant part of the nervous system; and it is particularly by tracing such dependencies that pathological anatomists have diminished or sought to diminish the number of diseases previously regarded as ultimately dynamical.

Sympat

There is still another form of nervous conduction to which, under the name of sympathy, pathologists frequently refer in their explanations of morbid phenomena, and which, without being in itself a new source of such phenomena, occasionally modifies in a very important manner the relations between proximate causes of disease and the symptoms by which they manifest their existence.

There are, perhaps, few terms under which a greater diversity of phenomena have been sought to be comprehended than that of sympathy, owing in a great measure to the very imperfect analyses with which medical inquirers too frequently content themselves, of the succession of events by which an obvious result is preceded. To us it appears, that in medical language the term sympathy ought strictly to be confined to denote the arising of sensations, motions, or other vital changes, in the animal economy, suddenly and without the intervention of the will, from external or internal impressions made upon, or irritations excited in parts distinct or at a distance from, those in which these sensations, motions, or changes, actually occur; and in pathology more particularly to denote a certain co-suffering or condolence of different parts, in consequence of which, when one part is morbidly affected, either all the other parts of the body, or some particular and different part, is simultaneously affected, either in the same or in some different but obvious manner. When the sympathetic morbid affection extends to all parts of the body, as when the state of fever is produced by a wound, it is said to depend on the general sympathy of the economy. When, again, the sympathetic affection is limited to some particular part, as when the presence of stone in the bladder gives rise to itchiness and pain at the extremity of the urethra, it is said to depend upon a particular sympathy.

The great variety of pathological phenomena which have been regarded as sympathetic, may perhaps be referred to two general classes, sympathetic sensations and sympathetic motions. According to the general definition that has been given of pathological sympathetic phenomena, it obviously follows that sympathetic sensations are those which we experience in a part distinct from that to which the exciting cause is applied; as when the sensation of itchiness of the nose is occasioned in children by the presence of worms in the intestines. Sympathetic motions, in like manner, are those that occur in particular muscles or muscular organs, in consequence of the application of a physical stimulus to a part distinct from that to which they immediately belong, and with which they cannot be shown to have a direct nervous communication; as when cramps occur in different muscles, particularly those of the lower extremities, from the presence of acid or of bile in the alimentary canal; or when disturbance of the action of the heart is produced by the same causes.

In every sympathetic phenomenon, two distinct parts of the body must be considered as being concerned; 1*st*, that on which the primary impression of the external agent is made; and, 2*d*, that in which the sympathetic effect is manifested. In speaking, therefore, of the sympathies of any organ, as the stomach, for example, we may consider it either, 1*st*, as being the part primarily acted on by an external impression; or, 2*d*, as being the seat in which the operation of the external impression becomes apparent to us by the production of the sympathetic effect. It has been to mark this distinction that the terms active and passive sympathies have been employed; an organ being said to have an active sympathy with another organ, when an impression made on the first is followed by a sympathetic affection of the second organ, while, in this case, the second organ is said to have a passive sympathy with the first.

"In endeavouring to discover some general principle or principles capable of accounting for the phenomena of sympathy, medical men have been led to believe that sympathetic connections exist principally between parts bearing a close resemblance to one another in their structure, or having a community of function, and between parts connected with one another by means of vessels and nerves, or situated in the vicinity of one another. Finding that the two former of these circumstances, resemblance of structure and similarity of function, did not lead to any satisfactory explanation of the phenomena of sympathy, attention was more particularly directed to the two last of the circumstances mentioned, especially to the communication existing between parts, whether near to or remote from one another, through the medium of nerves. It was soon observed that there are four ways in which a connection may be established between distinct or distant parts, through the medium of nerves; 1*st*, the same nerve may in its course pass through different parts; 2*d*, a nerve may send branches to different parts; 3*d*, two or more nerves going to different parts may arise from the same portion of the central part of the nervous system,—the brain and spinal marrow; 4*th*, two or more such nerves, though arising from different portions of the common sensory, may be connected with one another in their course by anastomosing branches. These possible different modes of nervous communication suggested to physiologists the further inquiry, whether, when a sensation, motion, or other vital action arises in some part of the body, in consequence of an impression made on some other distinct part, the impression must first be communicated from the part primarily affected, to the brain, and from thence be transmitted to the part in which the resulting sensation or action occurs; or whether the impression may pass directly from the part on which the external agent operates, to the part ultimately sympathetically affected, without passing through the brain."

Vit affinity.

Physiologists are accustomed to assert, with very considerable confidence, that the chemical processes or operations which take place in organized beings are regulated by laws not only different from, but opposed to, those that preside over the chemical changes which occur in inorganic bodies; and that it is consequently necessary to admit the agency, in their production, of a principle different from any recognised in inorganic chemistry. To this principle, when regarded as distinct from the general vital principle of some physiologists, they give the name of vital affinity. The arguments alleged in favour of the existence of such a principle are threefold: *First*, that we are unable to render an explanation of many of the chemical processes occurring in organized bodies; *second*, that in living systems, chemical combinations are effected, or organic compounds are formed, to which nothing analogous is met with in dead matter, and which the chemist is unable to imitate; and, *third*, that elements remain combined in living systems, which, under the ordinary laws of chemical affinity, would speedily separate from one another, so as to produce decomposition of their compound products. Notwithstanding the confidence with which these arguments have been urged, and the assent which they have very generally received, to us, we confess, it appears that if there really exist in living economies any principle or principles capable of producing chemical combinations and decompositions different from those of inorganic chemistry, both its general character, and the particular phenomena which depend upon its agency, remain yet to be discovered.

It is no way impossible that nature may employ in living economies a peculiar principle of chemical action, just as, in the case of irritability at least, she employs in the animal kingdom a peculiar principle of physical action. But, supposing this to be the case, from the harmony which we find to prevail through all parts of nature's works, we may be assured that this chemico-vital principle, if it actually exists, must be supplementary and additional to, and not inconsistent with or subversive of, those other principles which regulate the phenomena of chemical combination and decomposition.

In regard to the first argument which we have mentioned in favour of the existence of a particular principle of vital affinity, it would not, we believe, be difficult to show that our inability to render an explanation of many of the chemical processes that go on in the animal economy, is owing to our ignorance of the phenomena as they actually occur—to our seeing the results only, and not the means by which they are brought about; that, so far as we are acquainted with the chemical phenomena of the animal economy, they do not exhibit anything inconsistent or irreconcileable with the ordinary laws of chemical affinity as manifested in the inorganic world; and that the better we become acquainted with the circumstances under which chemical actions take place in living bodies, the more are we enabled to explain them conformably with these laws.

In regard to the second argument, it might, we conceive, be shown, that it is not universally true that organic compounds cannot be imitated exterior to living economies, as is shown by the preparation of oxalic acid, of sugar, of camphor, of allantoic acid, and of urea, in the laboratory of the chemist; and that even though the chemist were unable to imitate organic chemical products, this would not be a conclusive argument in favour of the existence of a distinct vital chemical principle, unless we could show that the means employed by him in his attempts to effect this were, in every other essential, analogous to those which nature employs in the living economy.

The third argument which we have mentioned, is that upon which the supporters of a principle of vital chemical affinity have most confidently relied. They appeal triumphantly to the changes which an organized body undergoes subsequently to death, as exhibiting the natural tendencies of the elements of which its several parts consist, under the ordinary laws of chemical affinity; and represent the prevention of these during life as the effect and the evidence of a peculiar chemico-vital principle. But it is strange that they should overlook how materially any one portion of an organized body, which they may mark as undergoing putrefaction subsequently to death, is altered in its circumstances from its condition during life, by the cessation of the processes of absorption, nutrition, exhalation, &c. And it is, perhaps, still more strange, that they should think it necessary to invoke a peculiar agent for the explanation of an effect, viz. the prevention of putrefactive decomposition, which, in the casks of the curer, or the jars of the anatomist, they may see effected by products of inorganic chemistry.

On the whole, we conclude, that the physiologist in prosecuting his investigation of the changes of combination and decomposition which occur in the animal economy in the state of health, and the pathologist in endeavouring to ascertain the deviations to which these are subject in the state of disease, are entitled to proceed on the belief, that whatever differences there may be in the resulting products, their formation is regulated by the same laws to which the chemical changes of inorganic substances are subjected; and that where these laws seem inadequate to the explanation of any particular phenomenon, they may be certain that the circumstances of that phenomenon are still imperfectly understood.

Conclusion.

We must here terminate the view which we have attempted to sketch of the vital powers that are concerned, conjointly with the powers common to all forms of matter, in producing the corporeal phenomena of the animal economy, and of the variations to which these powers are liable in the state of disease. Though very imperfect, we trust this view has been sufficient to show how little is as yet actually known of what may be called the mechanism of the functions, or the agencies engaged in the performance of their several parts; and how little, consequently, medical men are prepared to analyse and reduce to their primary elements those deviations from healthy exercise which the different functions experience in the various states of disease, independently of structural alterations. Hence it happens, that the pathologist is frequently compelled to stop short, in framing his proximate causes, at the general functional derangement of which he obtains evidence, instead of attempting to trace this back to the particular dynamical condition or conditions upon which it may depend; to be content with saying of a secretory organ, for example, that its *action* is excessive, deficient, or vitiated, instead of attempting to determine whether it is in its organic or in its inorganic forces, and in which of these respectively, that the primary source of derangement has its seat.

Before concluding, we shall only farther remark, that it is impossible to review the different sensible alterations of structure which have been enumerated in a former part of this article, as constituting the proximate causes of the various forms of organic diseases, without being satisfied that in very few instances are these the *immediate* results of the action of morbific agents on the several parts of the body; and that previous to the occurrence of those changes which render structural proximate causes perceptible to the senses, dynamical or imperceptible changes must have taken place, the nature of which can be for the most part only a matter of inference. The application of a ligature to a limb, or some other impediment to the return of the blood to the heart by the veins, may produce congestion, dropsy, or perhaps hæmorrhage, as its direct effect; but in those cases in which these morbid conditions occur in what is called an active form, their appearance must have been preceded by a dynamical affection of some portion of the circulatory system. Hence the opinion of those who maintain that the first changes towards disease are always dynamical, is correct, provided it be understood that this term signifies merely changes of action, independently of perceptible changes of structure; changes of action which must primarily originate in the injurious operation of morbific agencies on the insensible conditions of the several textures, systems, and organs of the body. (L. L. L. L.)

PATIENCE is that calm and unruffled temper with which a good man bears the evils of life, from a conviction that they are at least permitted, if not sent, by the best of Beings, who makes all things work together for good to those who love and fear him.

PATIENTIA STRAIT, in the Eastern Ocean, is formed by the south end of Gilolo Island, and the southern extremity of Bachian Island.

PATIGUMO, a corruption of the words *pâte de guimauve*, is the name of a sort of paste or cake much used on the Continent as an agreeable and useful remedy for catarrhal defluxions, and supposed by Dr Percival to consist of gum-arabic combined with sugar and the albumen of eggs. It has been said, however, that the powdered substance of the marshmallow is the chief ingredient of the composition.

PATIN, GUY, professor of physic in the Royal College of Paris, was born in the year 1602. He made his way in the world merely by the force of his genius, being at first only corrector of a printing-house. He was a man of great wit and erudition, and spoke with the gravity of a Stoic; but his expressions were nevertheless very satirical, and he hated bigotry, superstition, and knavery. Notwithstanding his sarcastic tendency, however, he was upright and well disposed, an affectionate father and an amiable member of society. He died in the year 1672, and owed his reputation, not to any writings upon physic published in his lifetime, but to his letters, which appeared after his death.

PATIN, *Charles*, son of the preceding, was born in Paris in 1633, and made so surprising progress, that he maintained, in Greek and Latin, theses on all parts of philosophy, in 1647. He studied the law in compliance with the wishes of an uncle, and was admitted as an advocate in the parliament of Paris; but he could not lay aside the study of physic, for which he had always a decided inclination. Having therefore quitted the law, he devoted himself to physic, and after taking his doctor's degree, he applied himself to practice with success. He afterwards travelled into Germany, Holland, England, Switzerland, and Italy. In 1676 he was appointed professor of physic in Padua; and three years afterwards he was created a knight of St Mark. He died in that city in 1694. His works are numerous, and well known to learned physicians.

PATKUL, JOHN REINHOLD, was descended of a noble family in Livonia, a province which then belonged to the crown of Sweden. The Livonians having been stripped of their privileges, and great part of their estates, by Charles XI., Patkul was deputed to prefer their complaint; a duty which he discharged with such eloquence and courage, that the king, laying his hand upon his shoulder, said, "You have spoken for your country as a brave man should, and I esteem you for it." Charles, however, was determined to punish the zeal and honesty which he thought fit to commend; and a few days afterwards he caused Patkul to be declared guilty of high treason, and condemned to death. Patkul, however, found means to escape into Poland, where he continued until the death of Charles. He hoped that his sentence would then have been reversed; but being disappointed in this expectation, he applied to Augustus king of Poland, whom he solicited to attempt the conquest of Livonia. Augustus, acting on this suggestion, possessed himself of Livonia; and afterwards, when Charles XII. entered the province to recover it, Patkul commanded in the Saxon army which opposed that remarkable man. Charles proved victorious; and Patkul some time afterwards entered the service of the Czar, a little before Charles compelled Augustus to abdicate the throne of Poland, and his subjects to elect Stanislaus in his stead. The Czar then sent Patkul, with the title of his ambassador, into Saxony, to induce Augustus to meet him at Grodno, that they might confer upon the state of their affairs. He succeeded, and the proposed conference accordingly took place; but immediately afterwards the Czar left Grodno for Astracan, to quell a rebellion which had broken out there. As soon as the Czar was gone, Augustus ordered Patkul, who was then at Dresden, to be seized as a state criminal. This proceeding surprised all Europe; for Patkul was not only an ambassador, but an ambassador from the only power that could afford him protection. Patkul, it seems, had discovered that the ministers of Augustus were to propose a peace to Charles upon any terms, and had therefore resolved to anticipate them, and procure a separate peace between Charles and the Czar. But his design was discovered; and, in order to prevent its success, Augustus ventured to seize his person, assuring the Czar that he was a traitor, and had betrayed them both.

Augustus was soon afterwards reduced to beg peace from Charles at any price, and the latter granted it upon certain conditions, one of which was, that he should deliver up Patkul. This reduced Augustus to a sad dilemma. The Czar had reclaimed Patkul as his ambassador; and, on the other hand, Charles demanded, with threats, that the prisoner should be put into his hands. Augustus, therefore, contrived an expedient by which he hoped to satisfy both. He sent some guards to deliver Patkul, who was prisoner in the castle of Königstein, to the Swedish troops; but by secret orders privately despatched, he commanded the governor to let him escape. The governor, however, though he received the order in time, disappointed its intention. He knew that Patkul was rich; and having it now in his power to permit him to escape, he demanded a large sum for the favour. Patkul refused to buy that liberty which he made no doubt would be gratuitously restored; and, in the mean time, the Swedish guards arrived with the order for his being delivered up to them. By this party he was carried to the head-quarters of Charles at Albranstadt, where he continued three months, bound to a stake with a heavy chain of iron. He was then conducted to Casimir, where, being ordered to be tried, he was, as a matter of course, found guilty by his judges. After being kept in a state of horrible suspense for several months, he was, on the 30th of September 1707, put to death, with circumstances of atrocious cruelty, having been broken alive on the wheel, and his agony prolonged with unheard-of barbarity.

Charles XII. has been severely censured for not pardoning Patkul, and we are not inclined to vindicate that sovereign. Yet it must be remembered that this unhappy man was guilty of a much greater crime than that which drew upon him the displeasure of Charles XI. He had incited foreign powers to attack his country when under the government of a boy; hoping, as he said himself, that it would in such circumstances become an easy conquest. He was therefore a rebel of the worst kind, and where is the absolute monarch to be found who would readily pardon such rebellion?

PATMOS, a small island of the Grecian Archipelago, celebrated as the place of banishment of the apostle St John, and where also he wrote his Revelations. It is situated a little to the south of Samos, on the coast of Asia Minor, is between thirty and forty miles in circumference, and now scarcely produces subsistence for the support of its scanty population. It is represented as having been more productive about fifty years back, but has been cruelly laid waste by the pirates who infest these seas. It does not now contain more than 300 inhabitants. In the interior are the remains of a monastery, in a strong position, where formerly the natives were accustomed to take refuge and defend themselves against piratical invaders. Long. 26. 40. E. Lat. 37. 30. N.

PATNA, a large and celebrated city of Hindustan, in the province of Bahar, of which it is the capital. It is a city of great antiquity, and is supposed to have been the Palibothra of the ancients. It is situated on the southern shore of the Ganges, which is here five miles wide during the rainy season, and deep enough to float a ship of war. The city is built along the river, and is one continued street for many miles along the Ganges, whilst it is only one mile in breadth. The houses of the natives are generally built of mud; but those of the Europeans, which extend from Bankipoor, are of brick, and make a very handsome appearance, which is not the case with the rest of the city. It contains several mosques and temples; but they are old, and without ornament. It was formerly fortified after the fashion of Hindustan, and still possesses a small citadel, which is now used as a barrack and store-house; but neither this nor the fortifications of the town could have resisted a regular attack of modern artillery for twenty-four hours, although it has often made an obstinate defence against the attack of Indian troops. The town is large and populous; and chintzes and dimities of various kinds are manufactured here, as well as cloths resembling diaper and damask linen. Flannels are also woven in the vicinity, as well as a sort of canvass from cotton. The neighbouring country produces the finest opium and saltpetre, and great quantities of wheat and other valuable grains; also sugar and indigo. Opium and saltpetre are strictly monopolized; but a considerable trade is carried on in all other articles. A large quantity of saltpetre is annually despatched for internal consumption, and for exportation. It was here that the English first established a factory, the remains of which are still to be seen, where two hundred English prisoners were massacred in 1763, under the orders of the German adventurer Somro, or Summers, then in the service of Meer Cossim; immediately after which the city was captured by the British, and has ever since remained in their possession. A monument is erected to the sufferers, in the European burying-ground. The Company have erected here a depôt to contain rice. It is a building of stone, in shape like a bee-hive, with two winding staircases on the outside, which have been ascended on horseback. Bankipoor, one of the suburbs of Patna, is the residence of the servants of the Company. They compose a numerous establishment, with liberal appointments. The travelling distance from Patna to Calcutta by Moorshedabad is 400 miles, from Benares by Buxar 155, from Delhi 661, from Agra 544, from Lucknow 316 miles. Long. 85. 15. E. Lat. 25. 37. N.

PATOMACK. See POTOWMACK.

PATONCE, in *Heraldry*, is a cross, flory at the ends, from which it differs only in this, that the ends, instead of turning down like a fleur-de-lis, are extended somewhat in the pattee form.

PATRAS, a city of Greece, known to the ancients by the name of *Patræ*, and to the Turks by that of *Batra*. It is situated in the gulf of the same name, in a plain which is green, and to appearance well cultivated, and, especially to the northward, has extensive fruitful vineyards. The currants grow most abundantly, and are as fine as those of Zante. Vast quantities of them are annually exported. They are spread in bunches along the ground, and in eight days are sufficiently dried, when the stalks are picked off, and they are laid on the ground in heaps, in the field, ready for the purchasers. The city once contained 12,000 inhabitants, but they suffered much during the hostilities which terminated in their independence. It was the residence of the British consul-general of the Morea, and of agents from most of the European nations. It was formerly celebrated for its fabrics of silk goods, but these have nearly disappeared, and there is scarcely any other manufacture except that of making leather saddle-bags. It has good anchorage, well sheltered, with from three to ten fathoms depth of water. Long. 21. 47. E. Lat. 38. 14. N.

PATREE, a large and populous town of Hindustan, in the province of Gujerat, and capital of a small district. It is defended by three walls, the inner one being surrounded by a good wet ditch, which, even in the dry season, contains a considerable quantity of water. It was formerly considered as a place of great strength, and is often mentioned in the annals of the country. But the fortifications are now in a state of decay, and are in many places falling to pieces. The north face is protected by a beautiful tank, which renders an attack on that quarter entirely impracticable; and the town, on the whole, is still one of the strongest places in India. This place formerly belonged to the rajah of Drangdra, an independent chief of Cottewar; and is now governed by a Hindu chief, who is tributary to the Poonah Mahrattas. Long. 71. 35. E. Lat. 22. 50. N.

PATRIARCH, PATRIARCHA, one of those first fathers who lived towards the beginning of the world, and became famous by their long lines of descendants. Abraham, Isaac, and Jacob, and his twelve sons, are the patriarchs of the Old Testament; Seth, Enoch, and others, were antediluvian patriarchs. The authority of patriarchal government existed in the fathers of families, and their first-born after them, who exercised all kinds of ecclesiastical and civil jurisdiction in their respective households; and to this government, which lasted till the time when the Israelites sojourned in Egypt, some have ascribed an absolute and despotic power, extending even to the punishment of death. In proof of this is produced the curse pronounced by Noah upon Canaan;[1] but it must be observed, that in this affair Noah seems to have acted rather as a prophet than a patriarch. Another instance of supposed despotic power is Abraham's turning Hagar and Ishmael out of his family;[2] but this can hardly be thought to furnish evidence of any singular authority vested in the patriarchs, as such, and peculiar to those early ages. The third instance brought forward to the same purpose is that of Jacob's denouncing a curse upon Simeon and Levi,[3] which is maintained by others to be an instance of prophetic inspiration rather than of patriarchal power. The fourth instance is that of Judah with regard to Tamar,[4] in reference to which it has been remarked, that Jacob, the father of Judah, was still living; that Tamar was not one of his own family; that she had been guilty of adultery, the punishment of which was death by burning; and that Judah on this occasion might speak only as a prosecutor, not as a judge. Upon the whole, however, it is difficult to say which of these opinions is most agreeable to truth. Men who believe that the origin of civil government, and the obligation to obedience, arise from a supposed original contract, either real or implied, will be naturally led to weaken the authority of the patriarchs; and those, again, who consider government as a divine institution, will be as apt to exalt that authority to the highest pitch that either reason or Scripture will permit them. It cannot be denied, that authority existed in fathers, and descended to their first-born, in the primitive ages of the world; and it is neither unnatural nor improbable to imagine, that the idea of hereditary power and hereditary honours was first taken from this circumstance. But whether authority has descended through father and son in this way to our times, is a circumstance that cannot in one instance be asserted, and may be denied in a thousand. The real source of the dignity and of the authority of modern times seems to have been skill in the art of war, and success in the management of conquests.

Jewish PATRIARCH, a dignity, respecting the origin of which there have been a variety of opinions; some thinking it of very ancient institution, whilst others contend that it is not older than the time of Nerva, the successor of Domitian. It seems probable that the patriarchs were of the Aaronic or Levitical race; the tribe of Judah being at that time too much depressed, and too obnoxious to the Romans, to be able to assume any external power. But of whatever tribe they were, their authority came to be very considerable. Their principal business was to instruct the people; and for this purpose they instituted schools in several cities. Having gained great reputation for extraordinary learning, zeal, and piety, they might, in time, not only have brought a great concourse of other Jews from foreign parts, as from Egypt and other western provinces of their dispersion, but likewise have proved the means of their patriarchal authority being acknowledged there. From these they at length ventured to levy a kind of tribute, in order to defray the charges of their dignity, and of the officers under them, whose business it was to carry their orders and decisions through the other provinces of the dispersion, and to see them punctually executed by all, that some shadow of union at least might be kept up amongst the western Jews. They likewise nominated the doctors who were to preside over their schools and academies; and these were in process of time styled *chiefs* and *princes*, in order to raise the credit of their dignity, or to imply the great regard which their disciples were to pay to them. These chiefs became at length rivals of the patriarchs; and some of them possessed both dignities at once, an usurpation which not only caused great confusion, but oftentimes very violent and bloody contests. However, as the Jewish Rabbin have trumped up a much older era for this patriarchal dignity, and have furnished us with a succession of patriarchs down to the fifth century, in which it was abolished, it may not be amiss to give our readers the substance of what they have written on the rise and progress of this order of men; at the same time showing the absurdity and falsehood of the pretended succession to this imaginary dignity.

According to the Rabbin, the first patriarch was Hillel, surnamed the *Babylonian*, because he was sent for from thence to Jerusalem about a hundred years before the ruin of their capital, or thirty years before the birth of Christ, to decide a dispute about the keeping of Easter, which on that day fell upon the Sabbath-day; and it was on account of his wise decision that he was raised to that dignity, which continued in his family till the fifth century. He was likewise looked upon as a second Moses, because, like the Jewish legislator, he lived forty years in obscurity, forty more in great reputation for learning and sanctity, and forty more in possession of this patriarchal dignity. They reckon him little inferior to that lawgiver in other excellencies, as well as in the great authority he gained over the whole Jewish nation. The wonder is, how Herod the Great, who was naturally so jealous, could suffer a stranger to be raised to such a height of power, barely for having decided a dispute which must in all likelihood have been adjudged by others long before that time.

However, Hillel was succeeded by his son Simeon, whom many Christians consider to have been the venerable old person of that name who received the divine infant in his arms. The Jews give him but a very obscure patriarchate, although the authors above quoted make him, also, chief of the Sanhedrim; and Epiphanius says, that the priestly tribe hated him so much for giving testimony to the divine child, that they denied him the rites of common sepulture. But it is hardly credible that St Luke should have so carelessly passed over his twofold dignity, if he had been really possessed of such, and have given him no higher title than that of a just and devout man.

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[1] Genesis, ix. 25.

[2] Genesis, xxi. 9, &c.

[3] Genesis, xlix. 7.

[4] Genesis, xxxviii. 24.

He was succeeded by Jochonan, not in right of descent, but of his extraordinary merit, which the Rabbin, according to custom, have raised to so surprising a height, that, according to them, if the whole heavens were paper, all the trees in the world pens, and all the men writers, they would not suffice to record all his lessons. He enjoyed his dignity but two years according to some, or five according to others; and was the person who, observing the gates of the temple to open of their own accord, cried out, "O temple, temple, why art thou thus moved? We know that thou art to be destroyed, seeing Zechariah hath foretold it, saying, 'Open thy gates, O Libanus, and let the flames consume thy cedars.'" Upon this he is further reported to have complimented Vespasian, or rather, as some have corrected the story, Titus, with the title of king; assuring him that it was a royal person who was to destroy that edifice, on which account they pretend that the Roman general gave him leave to remove the Sanhedrim to Japhne.

The Jewish writers add, that he likewise erected an academy there, which subsisted until the death of Akiba; that this was likewise the seat of the patriarch, and contained three hundred schools, or classes of scholars. Another he erected at Lydda, not far from Japhne, and where the Christians buried their far-famed St George. He lived an hundred and twenty years, and being asked what he had done to prolong his life, he returned this curious answer: "I never made water nearer a house of prayer than four cubits; I never disguised my name; I have taken care to celebrate all festivals; and my mother has even sold my head ornaments to buy wine enough to make me merry on such days, leaving me at her death three hundred hogsheads of it to sanctify the Sabbath." The doctors who flourished in his time were no less considerable, both for their number and character, particularly the famed Rabbi Chanina, of whom the Bath Col was heard to say, that the world was preserved for the sake of him; and Nicodemus, whom they pretend to have stopped the course of the sun, like another Joshua.

He was succeeded by Gamaliel, a man, according to them, of insufferable pride, and yet of so universal authority over all the Jews, not only in the west, but throughout the whole world, that the very monarchs suffered his laws to be obeyed in their dominions, not one of them offering to obstruct the execution of them. In his days flourished Samuel the Less, who composed a prayer full of the bitterest curses against heretics (meaning the Christians), which are still in use to this day. Gamaliel was no less an enemy to them; and yet both have been challenged, the former as the celebrated master of the great apostle of the Gentiles, the other as his disciple in his unconverted state.

Simeon II., his son and successor, was the first martyr who died during the siege of Jerusalem. The people so regretted his death, that an order was given, instead of ten bumpers of wine, which were usually drank at the funeral of a saint, to drink thirteen at his, on account of his martyrdom. These bumpers were in time multiplied, they tell us, to such shameful height, that the Sanhedrim was forced to make some new regulations for preventing so great an abuse.

These are the patriarchs which, the Rabbin tell us, preceded the destruction of the temple; and we need no farther confutation of this pretended dignity than the silence of the sacred historians, who not only make not the least mention of it, but assure us all along that they were the high priests who presided in the Sanhedrim, and before whom all cases relating to the Jewish religion were brought to be decided. It was the high priest that examined and condemned our Saviour, that condemned St Stephen, that forbade the apostles to preach in Christ's name, and that sat as judge on the great apostle at the head of that supreme court. The same may be urged from Josephus, who must needs have known and mentioned this pretended dignity, if any such had existed; and yet he is so far from taking the least notice of it, that, like the evangelists, he places the pontiffs alone at the head of all the Jewish affairs, and names the high priest Ananus as having had the care and direction of the war against the Romans; an evident proof that there were then no such patriarchs in existence.

To all this let us add, that if there had been any such remarkable succession, the Talmudists would have preserved it to future ages; whereas neither they, nor any of the ancient authors of the Jewish church, make any mention of it, but only some of their doctors, who wrote a considerable time afterwards, writers to whom little credit can be given in points of this nature, especially as there are such insurmountable contradictions amongst them, as no authors, either Jewish or Christian, have, with all their pains, been hitherto able to reconcile.

Upon the whole, it appears that, however much Jewish pride may have prompted them to falsify, and to claim an origin more ancient than it really was, they cannot be traced much farther back than the time of Nerva. Nor have the Jews been faithful in giving an account of the authority of these men. They have indeed exaggerated their power beyond all bounds, in the hope of repelling the arguments of Christians; for their power was far more showy than substantial. In time, however, they certainly imposed upon the people; and what power they did possess in such matters as were connected with religion, they exercised with great rigour. In particular, their pecuniary demands became very exorbitant; and this was the cause of their final suppression in the year 429.

Patriarchs, amongst Christians, are ecclesiastical dignitaries, or bishops, so called from their paternal authority in the church. The power of patriarchs was not the same in all, but differed according to the different customs of countries, or the pleasure of kings and councils. Thus the patriarch of Constantinople grew to be supreme over the patriarchs of Ephesus and Cæsarea, and was called the œcumenical or universal patriarch; and the patriarch of Alexandria had some prerogatives which no other patriarch but himself enjoyed, such as the right of consecrating and approving every single bishop under his jurisdiction.

The patriarchate has ever been esteemed the supreme dignity in the church. The bishop had only under him the territory of the city of which he was bishop; the metropolitan superintended a province, and had for suffragans the bishops of his province; the primate was the chief of what was then called a diocese, and had several metropolitans under him; but the patriarch had under him several dioceses, composing one exarchate, and the primates themselves were under him.

Usher, Pagi, De Marca, and Morinus, attribute the establishment of the grand patriarchates to the apostles themselves, who, according to the description of the world then given by geographers, pitched upon the three principal cities in the three parts of the known world, Rome in Europe, Antioch in Asia, and Alexandria in Africa, and thus formed a trinity of patriarchs. Others maintain that the name patriarch was unknown at the time of the council of Nice; and that for a long time afterwards patriarchs and primates were confounded together, as being all equally chiefs of dioceses, and equally superior to metropolitans, who were only chiefs of provinces. Hence Socrates gives the title patriarch to all the chiefs of dioceses, of whom he reckons ten. Indeed it does not appear that the dignity of patriarch was appropriated to the five grand sees of Rome, Constantinople, Alexandria, Antioch, and Jerusalem, till after the council of Chalcedon in 451; for when the council of Nice regulated the limits and prerogatives of the three patriarchs of Rome, Antioch, and Alexandria, it did not give them the title of patriarchs, though it allowed them pre-eminence and privileges as such; and hence, when the council of Constantinople adjudged the second place to the bishop of Constantinople, who till then was only a suffragan of Heraclea, it said nothing of the patriarchate. Nor is the term *patriarch* found in the decree of the council of Chalcedon, by which the fifth place is assigned to the bishop of Jerusalem; nor did these five patriarchs govern all the churches.

There were, besides, many independent chiefs of dioceses, who, far from owning the jurisdiction of the grand patriarchs, called themselves *patriarchs;* such as that of Aquileia; nor was Carthage ever subject to the patriarch of Alexandria. Mosheim[1] imagines, that those bishops who enjoyed a certain degree of pre-eminence over the rest of their order, were distinguished by the Jewish title of patriarchs in the fourth century. The authority of the patriarchs gradually increased, till about the close of the fifth century, when all affairs of moment within the compass of their patriarchate came before them, either at first hand or by appeals from the metropolitans. The consecrated bishops assembled yearly in council the clergy of their respective districts; pronounced a decisive judgment on those cases where accusations were brought against bishops; and appointed vicars or deputies, clothed with their authority, for the preservation of order and tranquillity in the remoter provinces. In short, nothing was done without consulting them; and their decrees were executed with the same regularity and respect as those of the princes.

It deserves to be remarked, however, that the authority of the patriarchs was not acknowledged throughout all the provinces without exception. Several districts, both in the eastern and the western empire, were exempted from their jurisdiction. The Latin church had no patriarchs till the sixth century; and the churches of Gaul, Britain, and other countries, were never subject to the authority of the patriarch of Rome, whose authority only extended to the nearer provinces. There was no primacy, no exarchate nor patriarchate, owned here; but the bishops, with the metropolitans, governed the church in common. Indeed, after the name of patriarch became frequent in the west, it was attributed to the bishops of Bourges and Lyons; but it was only in the primary signification, namely, as heads of dioceses. Du Cange says, that there were some abbots who bore the title of patriarchs.

PATRIARCHAL Cross, in *Heraldry*, is that where the shaft is twice crossed, the lower arms being longer than the upper ones.

PATRICIAN, a title given, amongst the ancient Romans, to the descendants of the hundred, or, as some will have it, of the two hundred, senators chosen by Romulus, and by him called *patres*, or fathers. Romulus established this order after the example of the Athenians, who were divided into two classes, viz. the ἐυπατριδαι, *patricii*, and δημοτικοι, *populares*. Patricians, therefore, were originally the nobility, in opposition to the plebeians. They were the only persons whom Romulus allowed to aspire to the magistracy; and they exercised all the functions of the priesthood till the year of Rome 495. But the cognizance and character of these ancient families being almost extinguished by a long course of years, and frequent changes in the empire, a new kind of patricians afterwards arose, who had no pretensions from birth, but whose title depended entirely upon the emperor's favour. This new patriciate, Zozimus tells us, was established by Constantine, who conferred the quality upon his counsellors, not because they were descended from the ancient fathers of the senate, but because they were the fathers of the republic or of the empire. This dignity in time became the highest of the empire. Justinian calls it *summa dignitas.* In effect, the patricians seem to have had the precedence of the *consulares*, and to have taken precedence of them in the senate; though Faber asserts the contrary. What confounds the question is, that the two dignities often met in the same person; because the patriciate was only conferred upon those who had gone through the first offices of the empire, or had been consuls. Pope Adrian made Charlemagne assume the title of patrician before taking that of emperor; and other popes have given the title to other kings and princes by reason of its eminence.

PATRICIANS, in ecclesiastical writers, were ancient sectaries, who disturbed the peace of the church in the beginning of the third century, and who were so called from their founder *Patricius*, preceptor of a Marcionite called Symmachus. His distinguishing tenet was, that the substance of the flesh is not the work of God, but that of the devil; and on this account his adherents bore an implacable hatred to their own flesh, which they sometimes carried so far as to kill themselves. They were also called *Tatianites*, and formed a branch of the *Encratitæ.*

PATRICK, St, the apostle of Ireland, and the second bishop of that country. He was born on the 5th of April 373, of a good family, at Kirkpatrick, near Dumbarton, in what is now called Scotland, but was then comprehended under the general denomination of Britain. His baptismal name signified, in the British language, valiant in war. During some inroad of certain exiles from Ireland, he was taken prisoner, and carried into that kingdom, where he continued six years in the service of Milcho, who had bought him of three different persons, whence Patrick acquired the name of *Cothraig*, or *Ceathar-Tigh*, that is, *four families.* Here he made himself master of the Irish language, and at last, having effected his escape, returned home on board a ship. About two years afterwards, he formed the design of converting the Irish; and, the better to qualify himself for this undertaking, he travelled on the Continent, where he continued thirty-five years, pursuing his studies under the direction of his mother's uncle, St Martin, bishop of Tours, who ordained him deacon, and afterwards under St German, bishop of Auxerre, who ordained him priest, and gave him his third name of Mawn or Maginim.

An ancient author, Henricus Antisioderensis, who wrote a book concerning the miracles of St German, considers it as the highest honour of that prelate to have been the instructor of St Patrick. "As the glory of a father shines in the government of his sons," says he, "out of the many disciples in religion who are reported to have been his sons in Christ, suffice it briefly to mention one by far the most famous, as the series of his actions shows, Patrick the particular apostle of Ireland, who being under his holy discipline eighteen years, derived no little knowledge in the inspired writings from such a source. The most godly divine pontiff, considering him alike distinguished in religion, eminent for virtue, and stedfast in doctrine; and thinking it absurd to let one of the best labourers remain inactive in the Lord's vineyard, recommended him to Pope Celestine, by his presbyter Segetius, who was to carry to the apostolic see a testimonial of the ecclesiastical merit of this excellent man. Approved by his judgment, supported by his authority, and confirmed by his blessing, he set out for Ireland; and being peculiarly destined to that people as their apostle, instructed them at that time by his doctrine and miracles; and now does and will for ever display the wonderful power of his apostleship." Lastly, Pope Celestine consecrated him bishop, at the same time giving him his most familiar name of ***Patricius***, expressive of his honourable descent, and to impart lustre and dignity to the commission which he now charged him withal for converting the Irish. Palladius had been there a year before him upon the same errand, but with little success; and the saints Kieran, Ailbe, Declan, and Ibar, were precursors both of Palladius and of Patrick. But the great office of apostle of Ireland was reserved for our prelate, who landed in the country of the Evolein, or at Wicklow, in the year 431. His first convert was Sinell, eighth in descent from Cormac king of Leinster; but not meeting with encouragement, he proceeded to Dublin, and thence to Ulster, where he founded a church, afterwards the famous abbey of Saul, in the county of Down. After labouring seven years indefatigably in this great work, he returned to Britain, which he delivered from the heresies of Pelagius and Arius; he then engaged several eminent persons to assist him, and visited the Isle of Man, which he converted in 440, when the bishopric was founded; in the year 448, he returned to the see of Armagh, which he had founded three years before; and in thirteen years more completed the conversion of the whole island. After giving an account of his commission at Rome, he once more returned to Ireland, and spent the remainder of his life between the monasteries of Armagh and Saul, superintending and enforcing the great plan of doctrine and discipline which he had established. After having established schools, and an academy, he closed his life and ministry at Saul Abbey, in the 120th year of his age, on the 17th of March 493, and was buried at Down, in the same grave with St Bridget, and St Columba the apostle of the Picts. Respecting his burial-place, however, there have been great disputes; and it has been a subject of as much debate with the religious, as Homer's birth-place formerly was amongst the cities of Greece. Those of Down lay claim to it, upon the authority of the following verses:

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[1] Ecclesiastical History, vol. i. p. 284.

These three in Down lie in tomb one,
Bridget, Patricius, and Columba pious.

Those of Glastonbury, in England, found on the old monuments of their church; and some Scotch writers affirm that he was both born and buried at Glasgow. His genuine works were collected and printed by Sir James Ware, 1656. His immediate successor in his see was St Binen or Begnus.

Order of St Patrick, an institution which was founded in Ireland in the year 1783. On the 5th of February in that year, the king ordered letters patent to be passed under the great seal of the kingdom of Ireland, for creating a society or brotherhood, to be called "knights of the illustrious order of St Patrick," of which his majesty, his heirs and successors, were to be sovereigns, and his majesty's lieutenant-general and general governor of Ireland for the time being to officiate as grand master; and also for appointing Prince Edward, and several of the prime nobility of Ireland, knights companions of the said illustrious order.

PATRICK, *Simon*, a learned English bishop, was born at Gainsborough in Lincolnshire in 1626. In 1644 he was admitted into Queen's College, Cambridge, and entered into holy orders. After being for some time chaplain to Sir Walter St John, and vicar of the church at Battersea in Surrey, he was preferred to the rectory of St Paul's, Covent Garden, London, where he continued all the time of the plague in 1665 amongst his parishioners. In 1668 he published his Friendly Debate between a Conformist and a Nonconformist. This was answered by the Dissenters, whom he had much exasperated; but by his moderation and candour towards them afterwards they were perfectly reconciled to him, and he brought over many of them to the communion of the Established Church. In 1678 he was made dean of Peterborough, where he was much beloved. In 1682, Dr Lewis de Moulin, who had been professor of history at Oxford, and had written many very bitter books against the Church of England, sent for Dr Patrick upon his sick bed, and made a solemn declaration of his regret on that account, which he signed, and it was published after his death. During the reign of King James, the dean's behaviour showed that he had nothing more at heart than the Protestant religion, for which indeed he ventured all that was dear to him, by preaching and writing against the errors of the Church of Rome. In 1687 he published a prayer composed for that difficult time, when persecution was expected by all who stood firm to their religion. The year after the Revolution, the dean was appointed Bishop of Chichester, and was employed with others of the new bishops to settle the affairs of the Church in Ireland. In 1691 he was translated to the see of Ely, in the room of the deprived Bishop Turner. He died in 1707, after having published various works, amongst which are his Paraphrases and Commentaries on the Holy Scriptures, in three vols. folio, which, with Lowth on the Proverbs, Arnold on the Apocrypha, and Whitby on the New Testament, form a regular and continued commentary in English on all the sacred books.

PATRIMONY, a right or estate inherited by a person from his ancestors. The term *patrimony* has also been applied to church estates or revenues; in which sense authors still say, the patrimony of the church of St Rimini, Milan, and so on. The Church of Rome has patrimonies in France, Africa, Sicily, and many other countries. To create the greater respect for the estates belonging to the church, it was usual to give their patrimonies the names of the saints who were held in the highest veneration. Thus the estate of the church of Ravenna was called the *patrimony of St Apollinarius;* that of Milan, the *patrimony of St Ambrose;* and the estates of the Roman Church were called the *patrimony of St Peter in Abbruzzo*, the *patrimony of St Peter in Sicily*, and the like.

PATRINGTON, a town of the east riding of Yorkshire, in the wapentake of Holderness, 109 miles from London. It is situated on the river Humber, which is navigable beyond it, but does not now admit such large vessels as formerly. There is a good market, which is held on Saturday. The population amounted in 1801 to 894, in 1811 to 1016, in 1821 to 1244, and in 1831 to 1298.

PATRIOTISM is a love of one's country, one of the noblest passions that can warm and animate the human breast. "Zeal for the public good," says Mr Addison, "is the characteristic of a man of honour and a gentleman, and must take place of pleasures, profits, and all other private gratifications:" "whosoever wants this motive, is an open enemy, or an inglorious neuter, to mankind, in proportion to the misapplied advantages with which nature and fortune have blessed him." This love of our country does not import an attachment to any particular soil, climate, or spot of earth, where perhaps we first drew our breath, though those natural ideas are often associated with the moral ones, and, like external signs or symbols, help to ascertain and bind them; but it imports an affection to that moral system or community which is governed by the same laws and magistrates, and the several parts of which are variously connected one with the other, and all united upon the basis of a common interest. Wherever this love of our country prevails in its genuine vigour and extent, it swallows up all sordid and selfish regards; it conquers the love of ease, power, pleasure, and wealth; nay, when the partialities of friendship, gratitude, private affection, or regards to a family, come in competition with it, it teaches us to sacrifice all, in order to maintain the rights and promote and defend the honour and happiness of our country.

PATRIPASSIANS, Patripassiani, in *Ecclesiastical History*, a Christian sect, who appeared about the latter end of the second century, and were so called from their ascribing the passion to the Father. They asserted the unity of God in such a manner as to destroy all distinctions of persons, and to make the Father and Son precisely the same; and in this they were followed by the Sabellians and others. The author and head of the Patripassians was Praxeas, a philosopher of Phrygia, in Asia. Swedenborg and his followers seem to hold the same faith.

PATROCLUS, a Grecian chief at the Trojan war. He was the son of Menœtius, by Sthenele, whom some call Philomela or Polymela. The accidental murder of Clysonymus, the son of Amphidamas, in the time of his youth, forced him to fly from Opus, where his father reigned. Having gone to the court of Peleus, king of Phthia, he was cordially received, and contracted the most intimate friendship with Achilles, the king's son. When the Greeks proceeded to the Trojan war, Patroclus went with them at the express desire of his father, who had visited the court of Peleus; and he accordingly embarked with ten ships from Phthia. He was the constant companion of Achilles, lodging with him in the same tent; and when the hero refused to appear in the field of battle, because he had been offended by Agamemnon, Patroclus imitated his example, and by his absence became the cause of much evil to the Greeks. At last, however, Nestor prevailed upon him to return to the war, and Achilles permitted him to appear in his armour. The bravery of Patroclus, together with the terror which the sight of the arms of Achilles inspired, soon routed the victorious armies of the Trojans, and obliged them to fly for safety to the city. He would have broken down the walls; but Apollo, who interested himself for the Trojans, opposed him; and Hector, at the instigation of that god, dismounted from his chariot to attack him as he attempted to strip one of the Trojans whom he had slain. The engagement was obstinate; but Patroclus was at length overpowered by the valour of Hector and the interposition of Apollo. His arms became the property of the conqueror; and Hector would have severed his head from his body had not Ajax and Menelaus prevented it. His body was at last recovered, and carried to the Grecian camp, where Achilles received it with the loudest lamentations. His funeral was observed with the greatest solemnity. Achilles sacrificed near the burning pile twelve young Trojans, four of his horses, and two of his dogs; and the whole was concluded by the exhibition of funereal games, in which the conquerors were liberally rewarded by Achilles. The death of Patroclus, as described by Homer, gave rise to new events. Achilles forgot his resentment against Agamemnon, and entered the field to avenge the death of his friend; and his anger was gratified only by the slaughter of Hector, who had more powerfully kindled his wrath by appearing at the head of the Trojan armies in the armour which had been taken from the body of Patroclus. The patronymic of Actorides is often applied to Patroclus, because Actor was father to Menœtius.

PATROL, in war, a round or march made by the guards or watch in the night time, to observe what passes in the streets, and to secure the peace and tranquillity of a city or camp. The patrol generally consists of a body of five or six men, detached from a body on guard, and commanded by a serjeant.

PATRON, amongst the Romans, was an appellation given to a master who had freed his slave. As soon as the relation of master expired, that of patron began. For the Romans, in giving their slaves their freedom, did not despoil themselves of all rights and privileges in them; the law still subjected them to considerable services and duties towards their patrons, the neglect of which was very severely punished.

Patron was also a name which the people of Rome gave to some great man, under whose protection they usually placed themselves, paying him all kinds of honour and respect, and denominating themselves his clients; whilst the patron, on his side, granted them his credit and protection. They were therefore mutually attached and mutually obliged to each other; and by this means, in consequence of reciprocal ties, all those seditions, jealousies, and animosities, which are sometimes the effect of a difference of rank, were prudently avoided. For it was the duty of the patron to advise his clients in points of law, to manage their suits, to take care of them as of his own children, and secure their peace and happiness. The clients were to assist their patrons with money on several occasions; to ransom them or their children when taken in war; to contribute to the portions of their daughters; and to defray, in part, the charges of their public employments. They were never to accuse each other, or take contrary sides; and if either of them was convicted of having violated this law, the crime was equal to that of treason, and any one was allowed to kill the offender with impunity. This patronage was a tie as effectual as any consanguinity or alliance, and had a wonderful effect towards maintaining union and concord amongst the people for the space of six hundred years, during which time we find no dissensions or jealousies between the patrons and their clients, even in the times of the republic, when the populace frequently mutinied against those who were most powerful in the city.

Patron, in the Church of Rome, a saint whose name a person bears, or under whose protection he is placed, and whom he takes particular care to invoke; or a saint in whose name a church or order is founded.

PATRONAGE is a real or heritable right, of a peculiar nature, connected with ecclesiastical benefices, and of which the main privilege is that of presenting a person to the bishop, presbytery, or other competent ecclesiastical functionaries, in order to his being admitted, according to the rules of the church, to the ecclesiastical office to which the benefice is attached, and of being thereby inducted into the possession of the benefice. This right had its origin in the choice by particular churches, or the appointment by the prince on their application, of defenders of their rights and patrimony. These were at first chosen from scholastics or lawyers, and afterwards from nobles and men of arms, and were termed *patroni, defensores, et advocati ecclesiæ*, from which last title comes the name *jus advocationis* or advowson, still applied to the right. Originally the privilege of presenting formed no part of the right of the patrons, who were chiefly guardians of the property of the church, with a certain interest in the funds, termed *patronagium*. In time, founders of churches, or those who acquired right to be so considered by adding to the building or to the endowment, came to be regarded as patrons; and the fourth council of Toledo, in the seventh century, gave to the descendants of founders a right to see that the incumbents did not embezzle or alienate the funds, to which the ninth council (691) added the right of nominating the successor, confining this privilege, however, to the original founder himself, without extending it to his heirs. The office of patron soon became hereditary, but it would appear, from the Novels of Justinian, that in his time the right of presentation was only allowed to the descendants of founders in the case of oratories or private chapels (*Nov.* 123, c. 18), the privilege in regard to churches being apparently confined to the original founder (*Nov.* 57, c. 2). Subsequently, however, the right of presenting was allowed to descendants in regard to churches also, which gradually became almost universally patronate; and ultimately a rule was introduced into the canon law, that where no right of patronage could be shown to exist, the benefice was to be deemed subject to that of the pope as universal patron. The general character of the right of patronage was the same in all the kingdoms where the canon law was received; and although some partial modifications may have been admitted since the Reformation in particular countries, its principal features remain unchanged. We shall content ourselves with a sketch of it as it exists in the northern portion of this island, which presents some peculiarities not unattended with interest.

In Scotland, as in the other countries of Christendom, the system of patronage, as it existed under the canon law, became universally prevalent; but it is not thought to have been introduced earlier than the tenth century. Before the Reformation, however, a very great change had taken place in the condition of the parochial benefices. A large proportion of these were from time to time annexed or appropriated, by grant of the patrons, to bishoprics, abbacies, priories, and other religious establishments. The benefices thus appropriated were termed patrimonial, and were no longer the subjects of the right of patronage. Such benefices were permanently filled by the bishops or religious houses, who drew the tithes as titular rectors, whilst the cures were served either by a member of the religious community to which the benefice was annexed, or by a chaplain or curate having a salary paid him for his services, or at times by a proper vicar drawing vicarage tithe, though in many cases the vicarages also became appropriated as well as the parsonages. A check was attempted to be opposed to this practice of annexation by a statute in the reign of James III. (1471, c. 43); but so general had it been, that at the period of the Reformation there were in Scotland only 262 non-appropriated parochial benefices out of the whole number, consisting of about 940. These 262 were of course the only patronate parochial benefices, and they were partly of laic patronage and partly subject to that of bishops or other ecclesiastics. On the Reformation, the benefices were generally retained by the Roman Catholic incumbents; and in regard to abbacies and other prelacies (as the greater benefices were termed), these were assumed to have fallen to the crown on the abolition of the religious bodies to which they belonged, and were gradually gifted by the crown, first by temporary titles, and ultimately by permanent grant and erection into temporal lordships, to the nobles and persons of influence about the court. The annexed churches of these prelacies were in general totally unprovided for, the obligation to maintain a stipendiary substitute, incumbent upon the religious establishment to which the benefice was attached, not being fulfilled by the new lay proprietors. To provide a maintenance to the ministers serving the cures of these churches, which constituted the greater proportion of the whole parochial churches, the third of the rents of all benefices, including abbacies and other prelacies, was directed to be levied, to form a fund, out of which special grants might be made to such ministers; but this fund of "thirds" was so misapplied, that in reality the ministers were for many years dependent mainly on the voluntary contributions of their congregations, or of individual proprietors in their parishes. For a considerable period these stipendiary cures remained free from patronage; but James VI., notwithstanding the remonstrances of the church, gradually erected them into benefices, subject to the patronage of the respective lords of erection, though, as Sir George Mackenzie, a high prerogative lawyer of the reign of Charles II., observes, "nothing could be so unjust or illegal as these patronages were."

In the meanwhile, as far as regarded the patronate parochial benefices, it had been enacted by a statute, passed in 1567, alongst with a series of acts abolishing Popery and recognising the reformed church, that, whilst the examination and admission of ministers were declared to be in the kirk, the presentation of *laic* patronages should be reserved to the just and ancient patrons. There was no reservation of *ecclesiastic* patronages, and the lay patron was required, within six months after he should come to the knowledge of the vacancy, to present a qualified person to the superintendent or others having commission of the kirk (who then executed the functions subsequently devolved upon presbyteries), otherwise the right of presenting was to fall to the kirk. It was further provided, that if the superintendent refused to admit the person presented by the patron, the latter might appeal to the superintendent and ministers of the province, in other words, to the provincial synod, and from them to the General Assembly, "by whom," the act bears, "the cause being decided, shall take end as they decern and declare." Small as was the number of unappropriated parochial benefices or parsonages to which ministers might be appointed as rectors, these were, in a great many instances, conferred upon persons not in the function of the ministry at all; and, even in 1592, it is set forth in a statute of that year, that these benefices had been generally "disponed to bairns and other persons altogether unable for the said office and function." To remedy this evil, all gifts of such benefices "to sik persons as are not in the function of the ministry, or able to discharge the duty thereof," are by the act declared to be null, with an exception as to those conferred on senators of the College of Justice (the judges of the supreme civil court); and by another statute of the same year, establishing the presbyterian form of church government as it at present exists, presentations were appointed to be directed to presbyteries, which had been generally erected in 1581, with power to them to give collation; but providing always, that they should be bound to receive and admit whatever "qualified minister" should be presented by the king or laic patrons. The same act provided that a previous statute of 1584, declaring the king's supremacy over all estates, as well "spiritual as temporal," and that he and his councils were judges competent over all persons spiritual or temporal, and in "all causes," should in no way be prejudicial "to the privilege that God has given to the spiritual office-bearers of the kirk," in regard, amongst other matters, to the "collation and deprivation of ministers." In 1612 presbytery was abolished, episcopal government restored, and the king's supremacy in all matters spiritual or temporal again unqualifiedly declared; and at the same time it was provided, that if the bishop, to whom presentations were now to be directed, should refuse to admit a "qualified minister" presented by the lawful patron, not only might the patron retain the fruits of the benefice in his own hands, but letters of horning might be obtained to compel the bishop, by the usual executorials of the law, "to do his duty" in admitting the person presented. The remedy thus provided applied only to the case of presentees who had been already admitted to the function of the ministry, as appears also to have been the intent of the provision as to the corresponding obligation on presbyteries to receive presentees, contained in the act 1592, and the privilege of retaining the stipend, provided also for the case of the presbytery's refusal to admit a qualified "minister," in another act of the same year, which is generally viewed as merely an additional clause of that termed the charter of presbytery; so that there does not appear to have been any remedy for refusal to admit a presentee not already in orders, nor any compulsitor to compel even the bishops (who were subject to legal diligence to enforce admission of a party ordained) to grant ordination.

In 1638 presbytery was restored, and the king's supremacy in matters spiritual disclaimed; and in 1642 his majesty agreed, that as to all crown patronages, he would present one out of a list or leet, to be furnished by the presbytery, and which they were to make up with the advice and consent of the greater part of the parishioners. The practical result of this method was, that in all parishes subject to the patronage of the crown, the particular individual for whom the parish declared a preference generally obtained the presentation; and in 1649 patronage was altogether abolished by an act of the estates of parliament. By this statute it was declared, that "whosoever should, upon the suit and calling of the congregation, after due examination of their literature and conversation, be admitted by any presbytery unto the exercise and function of the ministry in any parish within this kingdom," should, without any presentation, but simply "by virtue of their admission," be entitled to the stipend, manse, and glebe; and in order that the proper interests of congregations and presbyteries, and what should be accounted the congregation having such interest, might be determined, it was recommended to the General Assembly "clearly to determine the same, and to condescend upon a certain standing way for being a rule therein for all time coming." The General Assembly accordingly established a directory, which in substance provided that the session of the congregation were to elect a person, whom they were to nominate to the congregation; that if the people acquiesced and consented, the matter was to be reported to the presbytery, who were to take the party chosen on trials, and, if found qualified, to admit him; that if the major part of the congregation dissented, the matter should in like manner be reported to the presbytery, who were to order a new election, unless they found the dissent to be founded on "causeless prejudices;" but that if only a minority dissented, the presbytery were, notwithstanding, to proceed to the trials and settlement, unless relevant exceptions were verified to them. Under this arrangement matters continued till the Restoration, when episcopacy, the king's supremacy in matters spiritual, and absolute patronage, were re-established. These, again, were all done away at the Revolution, when the presbyterian church government was restored, and the matter of the appointment of ministers placed on a totally new footing. By the act 1690, c. 23, patrons were deprived of the right of presentation, in consideration of a sum of six hundred merks Scots (L.33. 6s. 8d. sterling), and of a right to all tithes in the parishes of which they were patrons, to which no one else could show a title. The six hundred merks were to be paid by the heritors of the parish, who were entitled to consign the money, and compel the patron to execute a formal renunciation; whilst the patron, on the other hand, had efficient remedies afforded him for enforcing payment of the compensation. The patron's right to present, however, ceased from the date of the act, and the privilege became competent to the new parties who were now to be intrusted with it, whether the compensation was paid or not. These consisted of the heritors of the parish, being Protestants, and the elders, who were jointly to propose a person to the congregation, "to be either approven or disapproven by them;" and if the congregation disapproved, the disapprovers were to give in their reasons to the presbytery, by whose judgment the "calling and entry" of the minister was to be determined. Under this statute only three or four parishes paid the compensation money, and obtained renunciations from the patrons. The heritors and elders being in possession of their privilege without payment, and not anticipating the repeal of a statute considered as an essential part of the Revolution settlement, naturally did not press payment of the sum, small though it was; whilst the patrons, entertaining the hope of at some favourable opportunity recovering their power, of course refrained from compelling payment, and granting renunciations, and thereby, for a consideration so trifling, cutting off that hope. The expectations of the patrons proved just, and in 1711, the 10th of Queen Anne, restoring their former rights, was passed. This measure, which originated with the opponents of the protestant succession, was hurried through the House of Commons before the members of the church were aware of it. A deputation was, however, immediately despatched by the commission of Assembly, who presented a remonstrance to the House of Lords, and offered every opposition in their power, but unsuccessfully; and no subsequent efforts to obtain its repeal, which were repeatedly renewed by the church, were of any avail. The assembly for many years inserted in their instructions to their commission an injunction to seize any favourable opportunity of applying to parliament for a repeal of this statute; but in 1784, the practice of inserting such injunction was discontinued, the majority of the clergy, now for a long period introduced by means of patronage, having become favourable to its subsistence; and the right still continues to rest upon the footing on which it was placed by the 10th of Queen Anne. By that statute, patrons, with the exception of the few cases where the six hundred merks had been paid, and renunciations obtained, had their former privileges restored, whilst they were also allowed to retain the rights to tithes granted them by the act 1690, as part of the compensation for the privilege then taken from them; and the sovereign, in addition to the proper crown patronages, acquired right to all those which had belonged to the bishops and archbishops, having previously at the Revolution, without any statutory authority, assumed possession, *jure coronæ*, of all the tithes and property belonging to these dignitaries.

The right of patronage, as now existing, is an heritable right, which may be feudalized, and it may be united to and pass along with lands; whilst in regard to all patronages to which no legal title can be shown, the king is held to be patron, being deemed by lawyers to have succeeded in that privilege to the pope. The patron is allowed six months after each vacancy to present; and the period, by the 10th of Queen Anne, runs, not from the time when he may come to the knowledge of the vacancy, as under the act 1567, but from the date of the vacancy itself. If the patron "neglect or refuse" to present within the six months, the presbytery of the bounds become entitled to exercise the privilege *jure devoluto;* but if he have executed a presentation, and taken all requisite steps for having it lodged with the moderator or clerk of presbytery within the proper time, he will not be held to have "neglected or refused," so as to admit the *jus devolutum,* although, from causes over which he has no control, the presentation may not actually have been so lodged; as, for instance, if the patron of a church in Orkney, residing in Edinburgh, should execute and despatch a presentation in amply sufficient time to reach its destination under ordinary circumstances, but it should not arrive in consequence of an unusual prevalence of storms till the six months have expired. Where a presentee has been rejected by a presbytery as disqualified, or on other legal ground, the patron is allowed as long a period to present a second time, as remained unexpired of the six months when his first presentation was lodged. If, however, he have presented a minister already holding a cure, or a party who will not take the oaths to government, or one who shall not within the six months accept or declare his willingness to accept, his presentation of such a party will not stop the currency of the six months;

but if the presentation shall through any cause become ineffectual, and the six months have expired, the *jus devolutum* will take effect, as if no presentation had been offered. This provision was introduced by the 5th Geo. I. c. 29, mainly for the purpose of preventing patrons from keeping benefices vacant by the presentation of parties who either were disqualified, or would not accept, or whose acceptance was dependent, as in the case of ministers already settled, on the will of the church courts. Although, usually, there is only room for the exercise of the patron's right when a vacancy occurs, the law, in special circumstances (where the presbytery are satisfied of the necessity of the proceeding, from the age or permanent illness of the incumbent), sanctions a presentation during his life to an assistant and successor, who, on being admitted and ordained by the presbytery, immediately becomes colleague in the pastoral charge, though he cannot enter into possession of any of the rights of the benefice till the death of the incumbent. In such cases a provision is always required by the presbytery to be made for the assistant and successor, either by the incumbent, or by obligation on the part of the parishioners, or certain of their number. The patron, before presenting, must take the usual oaths to government for persons in public trust; and if suspected of Popery he may be required to purge himself, by signing a special formula framed for that purpose. Any patron refusing to take the oaths, or to subscribe this formula, when required, forfeits his right of presenting for that time to the crown; and in the event of failure by the crown to present within six months, the *jus devolutum* accresces to the presbytery. Whether this disability can be evaded by the disqualified patron nominating a commissioner who can take the oaths, &c. seems not to be determined.

Originally there was no restriction on the patron's choice in regard to the persons from among whom he might select his presentee, provided always that on trial the presentee should be found qualified. By a series of legislative enactments, however, on the part of the church, a special class of persons has been constituted, from among whom alone (or ordained ministers previously taken from the same class) the patron must select his presentee. These are denominated expectants or probationers, or more generally, at the present day, licentitaes. They are required to go through a preparatory train of study, including a full university course of philosophy, and a course of theology, consisting of four years regular or six years irregular attendance on the professors of theology, in one or other of the universities. They are then taken on trials by the presbytery, that judicatory having previously satisfied themselves that the candidate is of "good report, sound in his principles, pious, sober, grave, and prudent in his behaviour; of a peaceable disposition, and well affected to the happy constitution established in this kingdom, both in church and state." The trials consist of examination into the candidate's knowledge of the Latin, Greek, and Hebrew languages, philosophy, theology, and church history, and the delivery of an exegesis in Latin on some controverted head of divinity, and three discourses in English, on which he may also be specially examined. If the presbytery be satisfied, and the candidate subscribe a formula acknowledging the Confession of Faith, and the presbyterian order of church government, and promising to submit himself to the judicatories of the church, they enrol him as a probationer, and grant him a license to preach the gospel. Though the party thus licensed possesses the privilege of preaching, and of leading in public worship, he holds no office in the church, he cannot administer the sacraments or marry, and is only considered as a recognised candidate on probation for the office of the ministry.

When a presentation in favour of a party qualified to accept of it in manner above mentioned, accompanied with his letter of acceptance, and certificate of his, and also of the patron's, having taken the oaths to government, is lodged with the presbytery, if there be any legal objections to it, or if another party dispute the right of presentation, the presbytery generally delay procedure till the question raised be disposed of by the civil courts; but if there be no legal objection, and no competition, they usually pronounce a deliverance sustaining the presentation (though in certain presbyteries no special deliverance is ever pronounced on the presentation), and proceed with the steps towards forming the pastoral relationship between the presentee and congregation, admitting him to the benefice, and ordaining him to the office of the ministry, if not already an ordained minister. The first step is to appoint the presentee to preach to the congregation one or more times as the presbytery may see fit, and to fix thereafter a day for moderating in a call, as it is technically termed, in his favour; that is to say, appointing the presbytery to meet at the parish church on a particular day, or commissioning one of their number to attend on that day, to moderate in or preside over a meeting of the congregation, summoned for the purpose of giving a call to the presentee to be their pastor. On this occasion, after public worship, and a sermon by the minister appointed to preside, the heritors, elders, and parishioners present are invited to subscribe a written call, addressed to the presentee, which, after setting forth that the parties subscribing are destitute of a pastor, and have sufficient assurance of his piety, literature, abilities, and suitableness to their capacities, proceeds thus: "We heartily invite, call, and entreat you to undertake the office of a pastor among us, and the charge of our souls, promising you, upon your accepting this our call, all dutiful respect, encouragement, and obedience in the Lord." The call being subscribed by as many as incline, the presbytery take it into consideration; and before proceeding to the trial of the qualifications of the presentee, they uniformly pronounce a deliverance, sustaining or concurring with the call. As this proceeding presents a marked peculiarity unknown in England, and as the question in regard to the competency of the church courts refusing to settle a presentee in respect of the absence of what they may consider a sufficient number of signatures to the call, or of the positive dissent from it by a majority of the congregation, or of the male heads of families in communion with the church, has given rise to keen discussion and most important consequences to the welfare of the church in past times, and has again become the subject of most anxious consideration, in a form which seems likely to lead to momentous results as regards the interests of the Church of Scotland, a short notice of its origin and history will probably be interesting and useful.

The Scottish reformers, in framing their scheme of church polity, adopted, in regard to the appointment of ministers, the principle confessedly acted on in the primitive ages of the church, when pastors were elected by the common consent of the clergy and people; and they allowed to the people that potential voice which they considered them to have enjoyed in the earliest times, prior to the introduction of those limitations and restrictions, which they conceived to have been imposed by the clergy at an after period, though still antecedently to the existence of patronage. Accordingly, in the First Book of Discipline, adopted in 1560, treating of "vocation," or calling to the office of the ministry, which, used in a large and general sense, is said to consist of "election, examination, and admission," our reformers declared, that "it appertaineth to the people and to every several congregation to elect their minister." For this purpose the congregation were allowed forty days, and if they failed within that time to present a person for examination, the superintendent, with his council (who exercised the functions now devolved on the presbytery), might present a person to them. It was, however, provided, that if, before the superintendent and his council, or superior church as it is termed, had thus offered them a minister, the inferior church or congregation had agreed upon a person who on examination should be found qualified, the latter was to be preferred to the party nominated by the superintendent and his council; but, on the other hand, if the congregation still failed to offer a person for examination, then they were to be judged unreasonable if they refused the party offered by the superintendent and his council, and might be compelled to receive him, by the censures of the church. In the Second Book of Discipline, agreed to by the church in 1578, it would rather appear, though that has been doubted, that the initiative was intended to be with the presbytery; but at all events the consent of the people was equally required; and it cannot be disputed that, in the intention of the framers of this book, the refusal to consent, though without reasons assigned and judged sufficient by the presbytery, was considered a fatal defect in the vocation to the pastoral office. Such being the system prescribed by the church, it so happened, from the peculiar state of matters in regard to the parochial cures, that for many years after the Reformation it became in practice the general rule for the appointment of ministers. As already noticed, the unannexed parochial benefices, which alone afforded an opportunity for the exercise of patronage, were comparatively few; these were not vacated by the Roman Catholic clergy, but only gradually fell by the death of the subsisting incumbents, when in most cases they were conferred *pleno jure*, by the crown and other patrons, on parties not in the function of the ministry at all. As to the remaining churches, constituting by far the larger proportion of the whole, there was no right of maintenance attached to them; and the ministers of these were appointed, not to a benefice, but simply to a cure of souls, with a chance of procuring a pension out of the general fund of "thirds," by special grant from the Exchequer, or otherwise being left to be supported by the contributions of their flocks. Of these cures, while they remained in this condition, there was of course no patronage, and thus, in by far the greater number of cases, there was no obstacle of the nature of a right of presentation to obstruct the rules prescribed by the church from being freely acted upon. Accordingly there is evidence that in general ministers were appointed during the first period after the Reformation, either by the direct choice of the people, or with their full consent. The manner of appointment was not always uniform, and the voice of the congregation was expressed in diverse ways; but still their voice was required and given; and this is stated by an author intimately acquainted with the records of the times (the late learned Dr M'Crie) to have been the case even where there existed a right of patronage.[1]

When the congregation themselves elected, their wishes appear to have been expressed in the form of a call or invitation, of which the very first election of a pastor amongst the reformers (the choice of Knox as colleague to John Rough by the congregation in the castle of St Andrews) affords an example, or rather the model, agreeably to which the after-practice was fashioned. In accordance with a prior agreement, Rough, after sermon, addressed himself to Knox in these words, as recorded in Knox's own history: "Brother, ye shall not be offended albeit I speak unto you that which I have in charge, even from all those that are here present, which is this: In the name of God and of his Son Jesus Christ, and in the name of those that presently *call* you by my mouth, I charge you that ye refuse not this holy vocation; but as ye tender the glory of God, the increase of Christ's kingdom, the edification of your brethren, and the comfort of me, whom ye understand well enough to be oppressed by the multitude of labours, that ye take upon you the public office and charge of preaching, even as ye wish to avoid God's heavy displeasure, and desire that he shall multiply his graces with you." And in the end, he said to those that were present, "Was not this your charge unto me? And do ye not approve this vocation." They answered, "It was, and we approve it." In general, it would appear that the congregation usually expressed their wishes by commissioners deputed by them to the presbytery, or others having commission to examine and admit, and at times in the form of a letter; but in either way their election assumed substantially the form of a call directed to the party chosen through the presbytery, or others having the power for the time of examination and admission; and, in whatever mode expressed, the consent of the people was in practice a constant requisite to admission. Thus, it was over a church in which, from the absence of patronage in most instances, consequent on the want of benefices, either proper or stipendiary, the practice of admitting the people to an effective voice, in accordance with the polity recognised by the church courts, had already been established, that patronage was gradually extended. By the more effective restriction of presentations in the case of proper benefices to persons who were really to exercise the function of the ministry, and the gradual increase of patronages by the erection of stipendiary benefices by the king, the right of presentation was by degrees again extended over nearly the whole churches of the kingdom. This, however, was not a sudden or violent change, but a progressive superinduction of a right of patronage over churches in which the practice of requiring the consent of the people was already fixed and universally prevalent; and, accordingly, as might have been expected, it continued to co-exist, although there is doubtless a deficiency of evidence in regard to the actual effect on the right of presentation in patronate churches. That the right of presenting on the part of the patron, and the privilege on the part of the people of their consent being required, did, to a certain extent, run counter to each other, and create some obstruction in the settlement of ministers, may fairly be inferred from an act of assembly in 1596, by which it was enacted, that any one seeking a presentation without consent of the presbytery, should be deemed *reus ambitus*, and as such should be rejected; and that effect was in use to be given to this enactment, is clear from a recorded instance in 1602, regarding the parish of Aberlady, in which, while the presentee was found not to have been *reus ambitus*, he having been in ignorance that a presentation was applied for on his behalf, he was obliged to subscribe an obligation, placing his presentation in the hands of the presbytery, and was only sent to the congregation on a leet with others, the privilege of the people in this instance being allowed to supersede in a great measure the right of the patron. By this time, too, the independence of the church had been very nearly extinguished; and, shortly afterwards, episcopacy, with its absolute patronage, was introduced. Even during its subsistence, however, and while the bishops might be compelled by legal diligence to admit a presentee in orders, the people appear to have persisted in claiming a voice, though, as may be supposed, generally without effect; evincing, however, how strongly the previous practice had been rooted in their ronage.

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[1] Life of Melville, vol. i. note EE, p. 467.

Patronymic.

habits. During all the previous period, and from the restoration of presbytery in 1638, down to the abolition of patronage in 1649, it would rather seem that there was no such form as that of "moderating" in a call. The congregation appear to have met by themselves, without the presbytery or a member of presbytery to moderate in or preside over their proceedings. When, however, the directory of 1649 vested the election in the session, as that body, during a vacancy, was without a moderator, and so incapable of acting as a session unless a moderator were supplied, the directory specially provided that one of the presbytery should be appointed to attend and moderate in the session at their act of election; and this is the origin of the peculiar phrase to "moderate in a call," which is still retained, although the meeting is of the congregation, and the presbytery as a body now usually attend themselves. Under this directory the election of the minister was vested in the elders of the congregation, at that time popularly chosen; and the voice of the people was subjected to this qualification, that the presbytery might disregard the dissent of a majority if they found it to be grounded on causeless prejudices. Under the act 1690, the heritors were joined with the elders, and the qualification enacted as to the voice of the people was more strict, the disapprovers of the person proposed being required to give in their reasons, to be judged of by the presbytery. The right of the heritors and elders under this statute was truly of the nature of a right of presentation, though in the act it was described as the right of "calling" a minister; a phraseology adopted, as is supposed, to render it more palatable to those most hostile to patronage. It was totally different, however, from the proper call by the congregation, although, undoubtedly, for some time after the act 1690 was repealed, a tendency to view the call with reference to that practice is apparent. For several years after the repeal of that act, in 1711, the exercise of the right of patronage was not attempted; and even when presentations began to be issued, they were usually in favour of a party who was likely to be preferred by the people; and the settlements in such cases uniformly proceeded on the call, without the slightest notice of the presentation. In like manner, for many years presentees never ventured to accept unqualifiedly a presentation; and the first instance of unqualified acceptance is said to have occurred in 1731. In the immediately preceding year a presentee had been for the first time since the passing of the 10th of Queen Anne settled in a parish by judgment of the Assembly, in virtue of a presentation, in opposition to the dissent of a majority of the people; and this judgment, which was an adherence to a sentence of the commission, was not rested on the merits of the cause, but was founded on the plea that the sentence of the commission was final and conclusive. After, however, such a settlement had once been accomplished, the Assembly proceeded avowedly on the ground of refusing effect to such dissents; and though several cases subsequently occur in which presentees were refused to be settled in consequence of dissents from the call, or deficiency of signatures to it, the general course of decisions was to sustain the call, without regard to the number of signatures or the extent of opposition (giving occasion to the two great secessions from the Church), till at last, towards the end of the century, the question as to the sufficiency of the call was rarely raised. In all cases, however, down to the present day, the invariable practice has been, that before proceeding to take the presentee on trials, a call is moderated in, and a judgment pronounced by the presbytery sustaining that call. Recently the disputes on this subject have been again revived; and, with a view to establish a definite rule for determining on the validity of the call, the church have passed an enactment, which sets out with a declaration that it is a fundamental law of the church that no pastor be intruded on a congregation contrary to the will of the people, and provides, that if the major part of the male heads of families in communion with the church, and members of the congregation, shall dissent from the call, the presentee shall be rejected. The legal effect of this provision, when acted on by a presbytery, is at present the subject of discussion in the courts of law.

Whatever may ultimately be determined on this point, it is the undisputed privilege of the congregation to give in, at the moderating in the call, specific objections to the presentee, which are not limited to his moral character and doctrine, nor to his talents or learning, but extend to every personal quality, of whatever nature, which may affect his fitness for the charge of the particular parish, viewed with reference to its peculiar characteristics and necessities. At any time, also, during the period allowed for trying the qualifications of the presentee, any of the communicants may proceed against him by libel, on any charge affecting his soundness in doctrine or his moral character; and, finally, when the trials are completed, and the presbytery are assembled for the purpose of ordination, any of them may appear in answer to the edict published to that effect, and demand to be allowed *instanter* to verify sufficient objections to the presentee's life or doctrine. In the mean time, the presbytery have subjected him to trials of a nature similar to those prescribed for licentiates; and if they are satisfied, and no valid objections have been offered, they ordain him to the office of the ministry, and admit him as pastor of the parish.

Besides the right of presentation, the patron was entitled, in the event of a wrongful refusal of his presentee, to retain the stipend in his own hand. By various statutes, however, he was subjected to the obligation of expending it on pious uses within the parish, though such a latitude was given in the interpretation of "pious uses" as to render the disposal of the stipend a matter of some interest to the patron. A recent statute, however, 54 Geo. III. c. 169, has transferred the vacant stipend to the fund for providing annuities to the widows of the clergy. Patrons also, in virtue of the act 1690, c. 23, are, as such, titulars or impropriators of all tithe in their parishes to which no one else can show right; this being a part of the compensation given them for the right of presentation thereby taken from them, and allowed to be retained by them after the right was restored; and, finally, if also heritors in the parish, they have right to the first choice of a family seat in the division and allotment of the area of the church. (R. R. R. R.)

PATRONYMIC, amongst grammarians, is applied to such names of men or women as are derived from those of parents or ancestors. Patronymics are derived from the father, as Pelides, that is, Achilles the son of Peleus; or from the mother, as Philyrides, that is, Chiron the son of Philyra; or from the grandfather on the father's side, as Æacides, or Achilles the grandson of Æacus; or from the grandfather by the mother's side, as Atlantiades, Mercury the grandson of Atlas; or, lastly, from the kings and founders of nations, as Romulidæ, the Romans, so called from their founder King Romulus. The terminations of Greek and Latin patronymics are chiefly four, viz. *des*, of which we have already given examples; *as*, as Thaumantias, that is, Iris the daughter of Thaumas; *is*, as Atlantis, that is, Electra, the daughter of Atlas; and *ne*, as Nerine the daughter of Nereus. Of these terminations, *des* is masculine; and *as*, *is*, and *ne* are feminine; *des* and *ne* are of the first declension, *as* and *is* of the third. The Russians, in their usual mode of address, never prefix any title or appellation of respect to their names; but persons of all ranks, even those of the first distinction, call each other by their Christian names, to which they add a patronymic. These patronymics are formed in some cases by adding Vitch, the same as our Fitz, to the Christian name of the father; and in others by

Of or Ef. The former is applied only to persons of condition, the latter to those of inferior rank.

PATROS, mentioned by Jeremiah and Ezekiel, appears from the context to mean a part of Egypt. Bochart thinks it denotes Upper Egypt; the Septuagint translate it the country of *Pathure;* Pliny speaks of the *Nomos Pathurites* in the Thebais; and Ptolemy mentions *Pathyris,* which was probably the metropolis. From the Hebrew appellation *Patros* comes the gentilitious name *Pathrusim.*

PATTAN, a town of Northern Hindustan, in the valley of Nepaul, situated at the distance of a mile and a half from the present capital of Catmandoo, from which it is separated by the Bhagmutty river. It stands on a small but elevated plain, and is said, whilst Patu existed as an independent state, to have comprehended 24,000 houses. It is a neater town than Catmandoo, and contains some handsome houses. Long. 85. 40. E. Lat. 27. 31. N.

Pattan, a town of Hindustan, in the province of Aurungabad, belonging to the nizam, thirty-eight miles south-west of Aurungabad. Long. 75. 33. E. Lat. 19. 29. N. It is the chief town of a district of the same name, in the province of Gujerat, situated about the 24th degree of north latitude. The country is but thinly inhabited, and is much exposed to the ravages of the numerous predatory tribes in this quarter of Gujerat. It contains the ancient capital of Gujerat, and is bounded on the west by the great salt lake called the Runn.

PATTEALAH, a town of Hindustan, in the province of Delhi, and district of Sirhind, and the residence of one of the Sikh chiefs. It is a place of considerable extent, and is now the most flourishing town in the district. It is surrounded with a strong mud wall, and has in the centre a square citadel, which contains the palace of the rajah or chief. It is said to have been founded about the year 1465, by Rai Ram Deo. It contains numerous tombs of devout Mahommedans. Long. 75. 38. E. Lat. 30. 18. N.

PATTI, a town on the northern coast of the island of Java, about 380 miles east of Batavia.

PATTIARY, a town of Hindustan, in the province of Agra, and district of Ferrukabad. Long. 79. 25. E. Lat. 27. 37. N.

PATTUR, or Puttugotta, a town of Bengal, in the district of Boglipore, pleasantly situated at the foot of a range of hills on the eastern bank of the Ganges, which is here very steep. Near this place is a rock covered with rude representations of the Hindu deities.

PAU, an arrondissement of the department of the Lower Pyrenees, in France, 641 square miles in extent. It comprehends eleven cantons, divided into 221 communes, and contains 110,100 inhabitants. The capital is a city of the same name, the seat of the departmental government and of the courts of law. It stands on the river Gave de Pau, in a fine valley, with romantic views of the neighbouring mountains. It is a well-built city, with a fine place or square, 1600 houses, and 11,600 inhabitants. Amongst the curiosities are the palace or castle in which Henry IV. of France was born. It has some manufactures of table and other linen, and others of cottons and hats, and considerable trade in wine, and especially in a celebrated kind of hams. Long. 0. 14. W. Lat. 43. 15. N.

Pau, one of the Tefee Islands, in the South Pacific Ocean, celebrated for sandal-wood. The inhabitants are said to be cannibals, although some Englishmen have of late resided on the island.

PAUCARTAMBO, a province of Peru, in the department of Cuzco, and situated to the east of the province and city of that name. It is traversed by a considerable stream of the same name, which flows into the Urubamba, one of the southern affluents of the Amazons. Considerable quantities of cocoa-leaf are annually exported from this province, and the land also produces rice, cacao, yucas, camotes, Indian corn, pine-apples, plantains, and other fruits, all in great abundance, and of most excellent quality. A large return, however, is only to be expected when the ground has been carefully cultivated; and this is seldom the case, owing to the indolent habits of the Indians, who are content to live for the most part on chuno or blanched potato, sesina or sun-dried meat, and aji or capsicum. Vegetables are scarcely ever seen, although the soil and climate admit of the production of most sorts for the table. Orange trees flourish remarkably well, and yield delicious fruit; but only a very few have been planted, so lazy and indifferent to the natural fertility of their country are the Indians. The Chunchos, as they are called, are, besides, a filthy, immoral people, and live so wretchedly that they suffer dreadfully from ague and fever, which carries them off in great numbers, there being no one exercising medical skill amongst them. Their favourite occupation is travelling with bow and arrow in hand through the forests in pursuit of game, monkeys, wild boars, and other animals. Paucartambo, the capital of the province, and situated fifteen leagues east-north-east from Cuzco, is thus described by General Miller, who traversed this hitherto unknown region in the year 1835. "This town, situated in a deep ravine, and on the banks of a mountain stream, was once of considerable importance, owing to its connection with the valleys twenty leagues distant, at the easternmost foot of the Andes, which formerly contained three curatos, and upwards of one hundred estates, principally cocoa-leaf plantations. Of the latter, owing to sickness, hostile inroads of the Indians, &c. only six now remain. Besides other causes of decay, one third of the houses of the town of Paucartambo have been carried away by its river within these few years, and it now contains only about some hundred inhabitants, mostly of Spanish blood, and distinguished for their superior intellect, good countenances, and urbane bearing, as compared with the rest of the population in the department of Cuzco."

PAUKPUTTAN, a town of Hindustan, possessed by native chiefs, in the province of Mooltan, 130 miles east by south from the city of Mooltan. Long. 73. 30. E. Lat. 30. 20. N.

PAUL, originally Saul, an apostle of Jesus Christ, and author of several portions of the New Testament canon. Though a native of Tarsus, a city of Cilicia,[1] he was the son of Jewish parents, belonging to the tribe of Benjamin.[2] From his father he inherited the rights of Roman citizenship,[3] which had probably been conferred upon some of his ancestors for some important services rendered to the commonwealth;[4] and it is with great probability supposed, that the cloak and parchments which he so earnestly charged Timothy to bring with him to Rome, were the Roman toga and the certificates of his citizenship, which he expected might be of use to him in his anticipated trial before the emperor. The name *Saul* (שאול), which he received at his birth, and which signifies "the longed-for, the desired," would seem to indicate that he was the first-born son of his parents, and that his birth was viewed by them as an answer to many prayers; that he was not, however, their only child, is apparent from Acts, xxiii. 16, where mention is made of his "sister's son." His father being of the sect of the Pharisees, probably devoted him from his infancy to the service of religion; and with this view he seems to have received such education as appeared most calculated to fit him for the duties to which he was destined. At that time Tarsus was eminently distinguished for its cultivators of philosophy, and every other department in the circle of instruction (σπουδὴ πρὸς τε φιλοσοφίαν καὶ τὴν ἄλλην ἐγκύκλιον ἅπασαν παιδειάν);[1] but to what extent the future apostle of Christianity was indebted to the labours of such teachers for his early education, no means are left us of judging. It is probable that his obligations were not very great; for as his ultimate destination was to the office of an expounder of the Jewish law and traditions, it does not appear likely that he would be sent by his parents to occupy himself with the literature and philosophy of those whom the Jews despised as outcasts, as well from the light as from the favour of heaven. At the same time, it cannot be denied that his residence in a city where the study of the liberal sciences was so assiduously and successfully prosecuted as to place it upon a par with "Athens, Alexandria, or any other place that could be named in which schools and studies are to be found,"[2] must have had a powerful influence in refining his taste, and liberalising and expanding his views. It was at Jerusalem, however, the centre of the Jewish world, that the most important part of his education was received. At an early age, in his twelfth or fourteenth year, as is supposed,[3] he was brought to this city, and placed under the instruction of Gamaliel, one of the most famous teachers of Jewish learning at that time.[4] Here he finished his education as a Pharisee, and at the same time, according to the custom of the Jews, acquired a mechanical art, that of a σκηνοποιός, which some render "a mechanist,"[5] others "a hair-cloth-maker,"[6] others "a maker of tapestry or carpeting," and others, with most apparent propriety, as in our version, "a tent-maker."[7] By this he probably supported himself during the time he was engaged in the prosecution of his studies, as we know he was in the habit of doing at an after-period whilst engaged as an apostle. How long he abode in Jerusalem at this time, or whether he returned to Tarsus at all before his conversion, are points on which no certain information can now be obtained. In the history of the early church, he is introduced to us, for the first time,[8] as "a young man,"[9] whose zeal for the religion of his fathers had prompted him to assume the character of an active persecutor of those who had forsaken that religion for the faith of Christ. On the occasion of the martyrdom of Stephen, he appears in the capacity of an abettor, and in some respects a sort of superintendent, of the act; and immediately after this, he, as if rendered more ferocious by the blood he had assisted in shedding, kindled the flames of a relentless and unsparing persecution, in which all, without respect of age or of sex, who had professed the hated religion, were compelled to blaspheme the name of Jesus, or obliged to endure the utmost indignities and the most condign punishments.[11] It was whilst engaged in these cruel efforts of a dark and bigoted zeal that he was made to experience that extraordinary change of opinion and feeling which gave a new direction to all his energies, and led him to devote his life to the advancement of that cause which he at first deemed it serviceable to God to oppose and destroy. Having obtained from the rulers of his nation a commission to go to Damascus, in which city the Jews were very numerous, and where also the new religion had obtained a footing, for the purpose apparently of arresting such of the Christians as had fled to that city, and bringing them back bound to Jerusalem, he was himself arrested by a higher power, and made to feel his utter impotency when attempting to oppose the cause of Christ. Whilst crossing the plain to the south of Damascus, about noon-day, and at a short distance from that city, he was suddenly surrounded by a miraculous light from heaven, which had the effect of so paralyzing him, that he fell to the ground, whilst a voice addressed to him the thrilling question, "Saul, Saul, why persecutest thou *me?*" In answer to the inquiry which he made in return, the voice said, "I am Jesus of Nazareth, whom thou persecutest; but arise and go into the city, and it shall be told thee what to do." Confounded, humbled, and agitated, he obeyed the heavenly vision; and as the brilliancy of the light had obscured his vision, he was led by his astonished attendants into the city, where he remained in a state of deep dejection for three days and nights, during which he tasted neither meat nor drink. From this painful condition he was relieved by the visit of a man named Ananias, who, at the command of Christ, sought him out, welcomed him as a brother, and baptized him into the profession of Christianity.[12]

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[1] Acts, xxii. 3, &c.

[2] Philip. iii. 5.

[3] Acts, xxii. 25-28.

[4] The opinion that the natives of Tarsus enjoyed the *jus civitatis* as a birthright, is not supported by evidence. The fact of that city's having been created by Augustus an *urbs libera* (Plin. v. 27) does not lead to any conclusion as to the possession by its natives of the right of Roman citizenship; and, from Acts, xxi. 39, compared with xxii. 24, 27, it may be inferred, that as the chief captain knew Paul to be a native of Tarsus, and yet was ignorant of his Roman citizenship, these two were not necessarily conjoined.

The first three years after his conversion were spent by

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[1] Strabo, lib. xiv. c. 5.

[2] Ibid.

[3] Greswell's Dissertations, vol. i. p. 554.

[4] Acts, xxii. 3.

[5] Michaelis, *Introd.* by Marsh.; Haenlein, *Einleitung*, ch. iii. s. 301.

[6] Eichhorn, *Einleit.* iii. 9; Hug, *Einleit.* ii. 213.

[7] "Persons travelling in the East, in order to shelter themselves from the rain and noxious blasts during the night, carry with them small tents made of leather or cloth; and the manufacture of these is a profitable occupation." (Winer, *Bib. Realwörterbuch* in *Paulus.*)

[8] Acts, vii. 58.

[9] Nothing satisfactory, however, can be drawn from this as to Paul's age at this period, for the word νεανιας is applied with much indefiniteness to persons of from twenty-four to forty years of age. Perhaps his age was about thirty.

[11] Acts, viii. 1–3; xxvi. 10, 11.

[12] Acts, ix. 1–18. The conversion of such a man, at such a time, and by such means, furnishes one of the most complete proofs that have ever been given of the divine origin of our holy religion. That Saul, from being a zealous persecutor of the disciples of Christ, became all at once a disciple himself, is a fact which cannot be controverted, without overturning the credit of all history. He must therefore have been converted in the miraculous manner in which he himself said he was, and of course the Christian religion be a divine revelation; or he must have been either an impostor, an enthusiast, or a dupe to the fraud of others. There is not another alternative possible.

If he was an impostor, who declared what he knew to be false, he must have been induced to act that part by some motive. (See MIRACLE.) But the only conceivable motives for religious imposture are, the hopes of advancing one's temporal interest, credit, or power; or the prospect of gratifying some passion or appetite under the authority of the new religion. That none of these could be St Paul's motive for professing the faith of Christ crucified, is plain from the state of Judaism and Christianity at the period of his forsaking the former and embracing the latter faith. Those whom he left were the disposers of wealth, of dignity, of power, in Judea; those to whom he went were indigent men, oppressed, destitute of all means of improving their fortunes. The certain consequence, therefore, of his taking the part of Christianity, was the loss not only of all that he possessed, but of all hopes of acquiring more; whereas, by continuing to persecute the Christians, he had hopes rising almost to a certainty of making his fortune by the favour of those who were at the head of the Jewish state, to whom nothing could so much recommend him as the zeal which he had shown in that persecution. As to credit or reputation, could the scholar of Gamaliel hope to gain either by becoming a teacher in a college of fishermen? Could he flatter himself, that the doctrines which he taught would, either in or out of Judea, do him honour, when he knew that "they were to the Jews a stumbling block, and to the Greeks foolishness?" Was it, then, the love of power that induced him to make this great change? Power! over whom? over a flock of sheep whom he himself had assisted to destroy, and whose very Shepherd had lately been murdered? Perhaps it was with the view of gratifying some licentious passion, under the authority of the new religion, that he commenced a teacher of that religion. This cannot be alleged; for his writings breathe nothing but the strictest morality, obedience to magistrates, order, and government, with the utmost abhorrence of all licentiousness, idleness, or loose behaviour, under the cloak of

Paul in Arabia,[1] where he received the Gospel he preached "by revelation from Christ," and where in solitude and quiet he was doubtless engaged in training himself for the work in which he was about to engage. On his return to Damascus, he openly appeared as a preacher of Christianity, a circumstance which the Jews felt to be so injurious to their cause, that they sought, by the aid of the governor, who was in all probability himself a Jew, to put him to death. Having by the aid of his Christian brethren escaped their malice, he betook himself to Jerusalem, where, after the fears of the brethren, who remembered his former enmity, but had not heard of his subsequent conversion to Christianity, had been removed by the testimony of his friend and companion Barnabas, he was gladly welcomed amongst them, and permitted to occupy that rank to which Christ had called him.[2] The enmity of the Jews again compelled him to change his residence. After being fifteen days in Jerusalem, he went to Cæsarea, and thence to his native city Tarsus, where he abode for several years.[3] In the mean time, Christianity, which had hitherto been preached only to the Jews, had received some adherents from amongst the Gentiles at Antioch; and this led to the mission of Barnabas from Jerusalem, for the purpose of instructing and regulating the church that had been formed there. Barnabas, after some time, finding the need of assistance and counsel, went to Tarsus, and returned with Paul to Antioch, where they abode for a year, occupied in united efforts for the promulgation of Christianity. At the close of that period, they were sent to Jerusalem by the Christians at Antioch, with the contributions which had been made by them on behalf of their brethren in Judea, who were suffering from the effects of a dearth.[4] This was Paul's *second* visit to Jerusalem since his conversion. After some months, they again returned to Antioch, accompanied by John Mark, the nephew of Barnabas. The cause of Christianity by this time had begun to flourish in that city, and several persons had been received into the church who were qualified to act as teachers to the rest. This rendered it the less necessary that Paul and Barnabas should remain any longer with them; and accordingly, shortly after their return, the church received a special command from heaven to set them apart to general missionary work. In obedience to this command, they were sent forth; and, accompanied by John Mark, who, however, soon deserted them and returned to Jerusalem, they visited Seleucia, Cyprus, Perga in Pamphylia, Antioch in Pisidia, Iconium, Lystra and Derbe, cities of Lycaonia (at the former of which, in consequence of Paul's curing a cripple, the people were on the point of offering him and his companion divine honours, under the impression that the gods had come down in the likeness of men, but were restrained by the vehement expostulations of those for whom these impious honours were designed; and in a few days after, they had so completely changed their minds, that, at the instigation of the Jews, they stoned Paul, and left him for dead); and then retracing their steps, they returned by way of Attalia, a city of Pamphylia, by sea to Antioch, where they rehearsed to the church all that God had

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religion. We nowhere read in his works, that saints are above moral ordinances; that dominion is founded in grace; that monarchy is despotism which ought to be abolished; that the fortunes of the rich ought to be divided amongst the poor; that there is no difference in moral actions; that any impulses of the mind are to direct us against the light of our reason and the laws of nature; or any of those wicked tenets by which the peace of society has been often disturbed, and the rules of morality often broken, by men pretending to act under the sanction of divine revelation. He makes no distinctions, like the impostor of Arabia, in favour of himself; nor does any part of his life, either before or after his conversion to Christianity, bear any mark of a libertine disposition. As amongst the Jews, so amongst the Christians, his conversation and manners were blameless. It has been sometimes objected to the other apostles, by those who were resolved not to credit their testimony, that having been deeply engaged with Jesus during his life, they were obliged, for the support of their own credit, and from having gone too far to return, to continue the same professions after his death; but this can by no means be said of St Paul. On the contrary, whatever force there may be in that way of reasoning, it all tends to convince us that St Paul must *naturally* have continued a Jew, and an enemy to Christ Jesus. If *they* were engaged on one side, *he* was as strongly engaged on the other. If shame withheld them from changing sides, much more ought it to have stopped him, who, from his superior education, must have been vastly more sensible to that kind of shame than the mean and illiterate fishermen of Galilee. The only other difference was, that *they*, by quitting their Master after his death, might have preserved themselves; whereas *he*, by quitting the Jews, and taking up the cross of Christ, certainly brought on his own destruction.

As St Paul was not an impostor, so it is plain he was not an enthusiast. Heat of temper, melancholy, ignorance, and vanity, are the ingredients of which enthusiasm is composed; but from all these, except the first, the apostle appears to have been wholly free. That he had great fervour of zeal, both when a Jew and when a Christian, in maintaining what he thought to be right, cannot be denied; but he was at all times so much master of his temper, as, in matters of indifference, to "become all things to all men;" with the most pliant condescension bending his notions and manners to theirs, as far as his duty to God would permit; a conduct compatible neither with the stiffness of a bigot nor with the violent impulses of fanatical delusion. That he was not melancholy, is plain from his conduct in embracing every method which prudence could suggest to escape danger and shun persecution, when he could do it without betraying the duty of his office or the honour of his God. A melancholy enthusiast courts persecution, and when he cannot obtain it, afflicts himself with absurd penances; but the holiness of St Paul consisted only in the simplicity of a godly life, and in the unwearied performance of his apostolical duties. That he was ignorant, no man will allege who is not grossly ignorant himself; for he appears to have been master not only of the Jewish learning, but also of the Greek philosophy, and to have been very conversant even with the Greek poets. That he was not credulous, is plain from his having resisted the evidence of all the miracles performed on earth by Christ, as well as those that were afterwards worked by the apostles; to the fame of which, as he lived in Jerusalem, he could not possibly have been a stranger. And that he was as free from vanity as any man that ever lived, may be gathered from all that we see in his writings, or know of his life. He represents himself as the least of the apostles, and not meet to be called an apostle. He says that he is the chief of sinners; and he prefers, in the strongest terms, universal benevolence to faith, and prophecy, and miracles, and all the gifts and graces with which he could be endowed. Is this the language of vanity or enthusiasm? Did ever fanatic prefer virtue to his own religious opinions, to illuminations of the Spirit, and even to the merit of martyrdom?

Having thus shown that St Paul was neither an impostor nor an enthusiast, it remains only to be inquired, whether he was deceived by the fraud of others; but this inquiry needs not be long, for who was to deceive him? A few illiterate fishermen of Galilee? It was *morally* impossible for such men to conceive the thought of turning the most enlightened of their opponents and the most cruel of their persecutors into an apostle, and to do this by a fraud in the very instant of his greatest fury against them and their Lord. But could they have been so extravagant as to conceive such a thought, it was *physically* impossible for them to execute it in the manner in which we find his conversion to have been effected. Could they produce a light in the air which at mid-day was brighter than the sun? Could they make Saul hear words from out of that light which were not heard by the rest of the company? Could they make him blind for three days after that vision, and then make scales fall off from his eyes, and restore him to sight by a word? Or, could they make him and those who travelled with him believe that all these things had happened, if they had not happened? Most unquestionably no fraud was equal to all this.

Since, then, St Paul was neither an impostor, an enthusiast, nor deceived by the fraud of others, it follows that his conversion was miraculous, and that the Christian religion is a divine revelation. See Lyttleton's "Observations on the Conversion of St Paul;" a treatise to which it has been truly said, that infidelity has never been able to fabricate a specious answer, and of which this note is a very short and imperfect abridgement.

[1] Galatians, i. 11–17

[2] Acts, ix. 20–28.

[3] Acts, ix. 30.

[4] Ibid. xi. 22–30.

done by them. This formed the apostle Paul's *first* great missionary tour.[1]

After some time spent at Antioch, he and Barnabas again went up to Jerusalem, for the purpose of consulting the apostles and elders in regard to some dissensions which had occurred in the church at Antioch, as to the obligation on Gentile converts of the Mosaic ceremonial. This gave occasion to the holding of a council at Jerusalem, at which, after much disputing, it was at length agreed unanimously, at the suggestion of the apostle James, that they should lay no stumbling-block in the way of their Gentile brethren, by requiring of them more than simply that they should abstain from meats offered to idols, from uncleanness, from things strangled, and from blood, whether pure or mixed with anything else. A letter to this effect was written to the church at Antioch in the name of the church at Jerusalem; and with this, two of the members of this church, Judas and Silas or Silvanus, were appointed to accompany Paul and Barnabas to Antioch.[2] By these means the difference of opinion amongst the brethren was removed, and the church restored to peace. This led Paul to propose to Barnabas another missionary tour, to which that faithful fellow-labourer having consented, they were on the verge of departure, when an unhappy contention, arising out of a determination on the part of Barnabas to take with them his nephew John Mark, a step which Paul firmly resisted, on the ground of Mark's former conduct in deserting them, produced a rupture between these two eminent individuals, and led to their prosecuting a separate course.[3] Whilst Barnabas, in company with his nephew, went to Cyprus, Paul, attended by Silas, went towards the east, and, passing through Syria and Cilicia, revisited the scenes of his former labours and sufferings in Lycaonia. At Lystra he found Timothy, a young man who had been probably converted to Christianity on the occasion of the apostle's former visit, and who was so highly commended by the church in that place that Paul selected him as the companion of his travels, having previously ordained him by the imposition of the hands of the presbytery.[4] Accompanied by him and Silas, the apostle next passed through the regions of Phrygia and Galatia, and avoiding Asia strictly so called, which he was forbidden by the Holy Spirit to enter, as well as Bithynia, they came by way of Mysia to Troas, a city and port on the borders of the Hellespont. Here he was directed by an apparition in a vision to go into Macedonia; and accordingly, with his companions, having crossed to Samothracia, and thence to Neapolis, a seaport of Thrace, he arrived in due course at Philippi. Here they remained for some time, and made many converts, amongst others the jailor of the prison, into which Paul and Silas had been thrust after having been scourged, in consequence of a charge which had been brought against them as disturbers of the peace of the city, by a set of impostors whose trade they had destroyed by expelling an evil spirit from a female slave who brought them much gain by her skill in soothsaying. From Philippi they passed through Amphipolis and Apollonia, cities of Macedonia, to Thessalonica, where, though they abode only a short time, they preached the gospel with great success. A tumult having arisen at the instigation of the Jews, the Christian converts, fearing for their safety, sent them by night to Berea, another city of Macedonia, about forty miles west of Thessalonica, where they were favourably received by their Jewish brethren, until a party which had followed them from Thessalonica stirred up a persecution against them. This determined Paul to go to Athens, whilst Timothy and Silas, as less obnoxious to the Jews, remained at Berea. It does not appear to have been the apostle's intention in the first instance in visiting Athens to preach the gospel there, at least until Timothy and Silas, to whom he had sent a message on his arrival, requiring them to join him, should have arrived; but as he waited for them, the sight of a city like that of Athens, entirely given to idolatry, so stirred and excited his spirit that he could no longer refrain; and accordingly, in the synagogues he disputed with the Jews, and in the market-place with such as he met. This led to his coming into contact with certain Stoic and Epicurean philosophers, by whom he was contemptuously invited to unfold his new doctrines, and describe the strange deities of which they supposed him to be the votary; and for this purpose he was taken to the Areopagus, where, with admirable tact, he exposed the follies of their idolatry, and commended to them the worship of the one living and true God, in the midst of a vast assemblage of people, on many of whom a favourable impression was produced by his address.[5] Having been joined by Timothy,[6] and in all probability by Silas also,[7] he sent the former again to Macedonia, and either retaining the latter in his company, or despatching him to some other quarter, he himself passed over to Corinth.[8] On the occasion of this his first visit to that city, he supported himself by his labours as a tent-maker, in company with a pious couple named Aquila and Priscilla, who had taken refuge in Corinth after having been expelled from Rome by an edict of Claudius Cæsar against the Jews; and at the same time he availed himself of every opportunity of urging the gospel of Christ upon the acceptance both of Jews and Greeks. Here he was rejoined by Silas and Timothy, with whom he continued a year and a half in active exertion for the advancement of Christianity. By the persevering enmity of his former opponents the Jews, he was again compelled to leave Corinth, and betake himself, along with Aquila and Priscilla, to Ephesus. Here he abode at this time only a few days, having been commissioned by a divine revelation to go up to Jerusalem in time for the approaching feast of the passover. On this journey, which ended in his paying his *fourth* visit to Jerusalem since his conversion, he was accompanied by Barnabas, with whom his former friendship had been re-established, and Titus, a Greek, who seems to have been a convert of Barnabas. After a brief residence there, he returned to Antioch, and so finished his second great apostolic tour.[9]

At Antioch he abode for some time, and then commenced another extensive tour, accompanied, as is supposed, by Titus. Passing through Phrygia and Galatia, where he revisited the churches he had formerly planted, he arrived at Ephesus. This city stood in the same relation to the region of Hither Asia in which Jerusalem stood to Palestine, Antioch to Syria, Corinth to Achaia, and Rome to the west; and accordingly the apostle made it his head-quarters for three years, during which time he was occupied in making converts in the city, and in paying short visits to the surrounding places, and to Crete and other islands of the adjoining archipelago. With so much success were his labours attended in Ephesus, that the revenues of those who were interested in the support of the idolatrous worship of the tutelar goddess of the city, Diana, began to be affected; and at the instigation of one of these, by name Demetrius, a silversmith, who carried on an extensive manufacture of miniature representations of the famous temple of Diana at Ephesus, a popular tumult was excited against the apostle, which was with difficulty appeased by the calm and sagacious conduct of the γραμματεύς, or town-clerk, who, along with others of the chief men in the place, seems to have been friendly towards Paul. Whether this tumult had any effect in quickening the apostle's determination to leave Ephesus, is uncertain; it is clear, however, that he had come to that determination before it happened.[1] By divine direction, he had resolved to go to Macedonia; and accordingly, shortly after the tumult, he departed from Ephesus, and went by way of Troas to Philippi. There he seems to have remained a considerable while, for, during his residence at Philippi as his head-quarters, he preached the gospel in all the surrounding districts, even as far as to Illyricum, on the eastern shore of the Adriatic.[2] Leaving Philippi, he paid a second visit to Corinth, where he abode three months, and then returned to Philippi, having been frustrated in his intention of proceeding through Syria to Jerusalem by the malice of the Jews. From Philippi he sailed for Troas, where he abode seven days; thence he journeyed on foot to Assos; and thence he proceeded by sea to Miletus, having visited several of the intermediate places. At Miletus he had an affecting interview with the elders of the church at Ephesus, to whom, in the prospect of seeing them no more, he gave a solemn and impressive charge, and bade them farewell. From Miletus he sailed for Syria, and, after visiting several intermediate ports, landed at Tyre, where he remained seven days. Thence he journeyed by way of Ptolemais and Cæsarea to Jerusalem, which he visited on this occasion for the *fifth* time since his conversion.[3]

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[1] Acts, xiii. xiv.

[2] Ibid. xv. 1–31.

[3] Ibid. xv. 36–41.

[4] 1 Tim. iv. 14.

[5] Acts, xvi. 17.

[6] 1 Thess. iii. 1.

[7] Greswell, vol. ii. p. 31, 32.

[8] 1 Thess. iii. 1, 2, 6, compared with Acts, xviii. 5.

[9] Acts, xviii. 1–22.

At Jerusalem he recounted to the whole church the events connected with the progress of Christianity of which he had been witness, and, apparently to quiet the scruples of some Jewish converts, who thought he had too lax and incorrect a view of the obligation of the Mosaic ritual, he united himself, at the suggestion of the apostle James, to four persons who had taken upon them the vows of Nazarites, and, entering with them into the temple, signified to the priest that he would pay the cost of the sacrifices which were necessary to absolve them and him from the vow. Whatever effect this compliance had on the minds of his scrupulous brethren, it procured for him no mitigation of the hatred with which he was regarded by the unconverted Jews. On the contrary, so eager was their zeal against him, that, before his vow was accomplished, they seized him in the temple, and would have put him to death, had not Lysias, commander of the Roman cohort in the citadel adjoining the temple, brought soldiers to his rescue. By his permission, and under his protection, Paul addressed to the infuriated mob an apology for himself, in which he set forth the main circumstances of his life from the beginning up to the period when he opened his commission to the Gentiles. At first he was listened to with attention, but as soon as he spoke of placing the Gentiles on a par with the Jews, they interrupted him with execrations, and shouted, "away with such a fellow from the earth, for it is not fit that he should live."[4] The Roman commander seeing these demonstrations of popular resentment, and being ignorant of what Paul had been saying, from the address having been uttered in the Hebrew tongue, imagined that he must be some execrable criminal, and gave orders that he should be brought into the fort, in order that he might by scourging compel him to confess his crime. From this indignity Paul saved himself by asserting his privileges as a Roman citizen, to bind or scourge whom was strictly forbidden by law. Next day the chief captain brought him before the Sanhedrim, for the purpose of hearing what it was that was urged against him; and here Paul again entered into a defence of his conduct, in the course of which he professed his attachment to the doctrine of a corporeal resurrection, and thereby stirred up a fierce controversy between the two parties composing the Sanhedrim, the Pharisees and the Sadducees, the former of whom maintained, whilst the latter denied, this doctrine. So angry and vehement did this discussion become, that the chief captain, fearing for the safety of his prisoner, whom, as a Roman citizen, he was bound to protect, commanded his soldiers to go down and remove him from amongst the combatants, into the fort. Upon the day following, above forty of the Jews entered into a solemn engagement neither to eat nor drink until they had killed Paul, and for this purpose proposed to the chief priests to invite him to a conference, in the hope that they might have an opportunity of assaulting him on his way from the fort. This scheme was rendered abortive by intelligence of it having been conveyed to Lysias by Paul's sister's son, who, alongst with his mother, seems to have been an early convert to Christianity.[5] Matters assuming this desperate aspect, Lysias determined to bring the whole under the consideration of the procurator; and, accordingly, placing Paul under the protection of a sufficient escort, he sent him to Cæsarea, with a letter to Felix, explaining the reasons of this step. After five days, Felix held a court, at which Paul and his accusers were brought together, and both parties heard at full length. The defence of the apostle was triumphant; but Felix, unwilling to offend the Jews, remanded him, under the pretence of obtaining farther information from Lysias. Some days afterwards, he summoned him again to his tribunal, in order that he and his wife Drusilla, who was a daughter of Herod Agrippa, might hear him "concerning the faith in Christ;" on which occasion, the apostle, with all that fearless zeal and faithfulness for which he was distinguished, expostulated so forcibly with the procurator in regard to those vices for which he was notorious, that Felix trembled, and hastily dismissed him from his presence. Shortly after this, Felix was removed from his office, and was succeeded by Porcius Festus, before whom the Jews again brought their charges against Paul. When both parties came to be heard, Paul perceived so evident a disposition in the new governor to favour the Jews, that he felt constrained to avail himself of the privilege which, as a Roman citizen, he possessed, of removing his cause from the province to the metropolis, by appealing to the emperor. This led to his being sent to Rome, but not before he had been again heard by Festus, attended by King Agrippa and his wife Bernice, by whom he was adjudged to have done nothing worthy of death or of bonds, so that he might have been set at liberty had he not appealed unto Cæsar. His voyage to Rome was long and disastrous. After coasting along Syria as far as Sidon, they struck across to Myra, a port of Lysia, having passed under Cyprus; thence they sailed slowly towards Cnidus, and thence, in consequence of the wind being contrary, to Crete, where they with difficulty put into a port on the southern side of that island, called the "The Fair Haven," near the city of Lasea. The season being now far advanced, Paul advised the centurion to proceed no farther; but the place not being suitable for wintering in, and the weather promising favourably, his advice was disregarded, and they again set sail, intending to reach Phœnice, a port in the same island, and there to winter. Scarcely, however, had they ventured to sea when the apostle's prediction was verified; for a boisterous wind arose and drove them at its mercy across the Mediterranean. In this state they continued for fourteen days, at the close of which they were shipwrecked on the coast of Malta, but without any loss of life. Here the apostle and his company remained for three months, during which time he was actively employed in

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[1] Acts, xix. 21.

[2] Rom. xv. 19.

[3] Acts, xx. xxi. 15.

[4] Acts, xxii. 22.

[5] Acts, xxiii. 16-22, compared with Rom. xvi. 7, 11, 21.

instructing the inhabitants, and performed many miracles for their benefit. On the approach of spring, they availed themselves of a ship of Alexandria that had wintered in the island, and set sail for Syracuse, where they remained three days; thence they crossed to Rhegium, and thence along the coast to Putcoli, from which place he journeyed by land to the imperial city. Here he was delivered by the centurion in whose charge he had come from Cæsarea, to the captain of the guard, who, with great lenity, permitted him to dwell in his own hired house, under the charge of a soldier.[1]

The sacred historian closes his narrative by informing us that Paul continued in this state of easy imprisonment for "two years, receiving all that came to him, preaching the kingdom of God, and teaching those things which concern the Lord Jesus Christ, with all confidence, no man forbidding him." Of the subsequent events of the apostle's life, consequently, we have much less direct and certain information; and from this has arisen much diversity of opinion on the subject. By many it is supposed that this his first imprisonment at Rome was his last, and that he perished in the persecution which Nero excited against the Christians, by representing them as the agents in the burning of the city; whilst others contend that he was set at liberty before that event, and that he set out on another great missionary tour to the west, in the course of which he preached the gospel throughout Spain, and, according to some, in Britain also;[2] revisited Ephesus and other places in Lesser Asia, passed over to Crete, returned to Ephesus, passed through Troas into Macedonia, thence to Nicopolis in Epirus, Dalmatia in Illyricum, and back again to Asia, when he was apprehended and conveyed to Rome the second time, where he suffered martyrdom. By some who hold this latter opinion the order of places visited is completely reversed, and Paul is supposed to have commenced his tour in Asia, and ended it in Spain. It would require a much larger space than this article can be permitted to occupy, to enter into any examination of the arguments and evidence on both sides of this question. Suffice it to remark, that whilst the whole subject is involved in much uncertainty, and whilst little more than probable conjecture can be furnished for the details of either hypothesis, the preponderance seems to be in favour of the latter. Our readers will probably be satisfied of this by a reference to what has been written on it by Mr Greswell and Professor Neander; the former of whom contends for it with all the zeal of an advocate, whilst the latter admits it with all the deliberation of a cautious and impartial judge.[3]

In the above sketch of the principal events of the apostle's life no attempt has been made to assign to each its proper date. This has resulted from the great perplexity in which this part of the subject is involved, and the consequent inexpediency of adopting any particular chronology without assigning the reasons on which it is founded; a course which would have extended this article greatly beyond its proper bounds. We have deemed it preferable, therefore, to present, in the first instance, the leading facts in the history of Paul in the order of their occurrence, and shall now furnish a table of the dates assigned to the more important of these in those systems of chronology which are most deserving of notice, leaving it with our readers to consult the works in which they are unfolded, for the arguments by which they are respectively supported.

	Usher.[4]	Greswell.[5]	Eichhorn.[6]	Neander.[7]
Paul's Conversion................	35	37	37 or 38	36
... 1st visit to Jerusalem (Acts, ix. 26).......	38	41	40 or 41	39
... 2d do. do. (Acts, xi. 30)	44	43	46	44
... 3d do. do. (Acts, xv. 4)	52	48	47?	50
... 4th do. do. (Acts, xviii. 22)............	56	52	56	54
... 5th do. do. and apprehension..............	60	56	60	58
... arrival at Rome.........	63	59	63	61
... liberation..................	65	61	...	62 or 63
... martyrdom.................	67	66	65 or 68	66?

During the brief intervals of comparative ease which the apostle enjoyed amid his arduous and almost incessant exertions as a preacher of Christianity, he wrote several treatises, more or less elaborate, both of a doctrinal and a practical nature, in the shape of epistles to different churches. Of these, thirteen, avowedly of his composition, and one that is with great probability ascribed to him (the Epistle to the Hebrews)[8] have come down to us; and there is good reason to believe that in these we have the whole of those compositions which, as an apostle of Jesus Christ, he gave to the church. It is supposed, indeed, by many distinguished biblical critics, that there is evidence in the first of his extant epistles to the Corinthians, of his having written one to that church antecedently to either of these; but the basis of evidence on which this rests is at best very slender, and the support which it lends to what is raised on it very doubtful.[9] In what order these epistles were written, and what date is to be assigned to each, are points on which much discussion has been expended. The following lists present the results of the investigations of Greswell and Neander; and the agreement of these two very able and independent inquirers in so many particulars may be safely regarded as an argument in favour of the general correctness of that scheme which, with trifling variations, both adopt.

Greswell.		
1st Thess. 2d Thess.	..from Corinth A D.	50.
1st Cor..............	Ephesus........	55.
2d Cor................	Macedonia.....	55.
Galat..................	Ditto	55.
Romans..............	Cenchrea......	56.
Ephes	Rome...........	60.
Coloss................	Ditto	60.
Philem...............	Ditto	60.
Philipp..............	Ditto	60.
Hebrews............	Puteoli.........	63.
Titus.................	Macedonia.....	64.
1st Tim..............	Nicopolis......	65.
2d Tim..............	Rome...........	66.

Neander.	
1st Thess. 2d Thess.	...from Corinth.
Galat....................	Ephesus.
1st Cor.................	Ditto.
2d Cor..................	Macedonia.
Romans................	Cenchrea.
Coloss..................	Rome.
Ephes..................	Ditto.
Philem................	Ditto.
Philipp................	Ditto.
1st Tim...............	Macedonia.
Titus..................	Crete.
2d Tim................	Rome.

Neander regards the Epistle to the Hebrews as of uncertain authorship, but deems it probable that it was written about the period of the apostle's martyrdom, by "some apostolic man of the Pauline school."[10]

In perusing the history and the writings of St Paul, it is impossible not to be struck with the amazing energy of thought and action by which he was characterized. The conception of *power* is impressed upon the mind by every view of his history, and the study of every page of his writings. The ease with which he threw off the prejudices of

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[1] Acts, xxi. 16; xxviii. 31.

[2] See Bishop Stillingfleet, Antiquity of the British Churches, vol. iii. p. 25–28, ed. 1770; and others.

[3] Greswell's Dissertations, vol. ii. pp. 78–100; Neander's *Geschichte d. Pflanzung und Zeitung d. Christliche Kirche*, u. s. w., &c. s. 267–281.

[4] *Annales Genevæ*, 1722, p. 568.

[5] Dissertations, &c. 5 vols. 1837.

[6] *Einleitung ins, N. T.* 3 bde.

[7] *Geschichte d. Pflanzung*, u. s. w.

[8] See Stuart's Commentary on the Hebrews, vol. i.

[9] See Blomfield, *Recensio Synoptica*, on 1st Cor. v. 9; and a note by the translator of Billroth's Commentary on the Corinthians (Edinburgh Biblical Cabinet, No. xxi. vol. i. p. 4).

[10] *Geschichte*, s. 281.

Judaism, notwithstanding the deep hold which these had taken of his mind; the rapidity with which he expanded his thoughts to embrace the vast conceptions unfolded by the free offers and unbounded claims of Christianity, so different from the narrow sectarianism of his former religion; the accuracy with which he received into his mind, almost instantaneously, and in all their multiplicity, the mutual bearings and relations of the old economy and the new; the dauntless intrepidity with which, from the very commencement of his Christian profession, he entered into discussion with the advocates of Judaism, and vanquished them with their own weapons; the unflinching perseverance with which, in spite of danger, suffering, contumely, persecution from enemies, ingratitude and desertion from friends, he prosecuted his arduous and exhausting labours; the unwearying assiduity with which he watched over the churches of which he had the care, and the promptitude and accuracy with which he adopted and executed measures for their advantage, widely scattered and variously circumstanced though they were; the resistless force of his arguments, the persuasiveness of his appeals, the bitterness of his irony; all conspire to show that he possessed, in a high degree, those capacities for command by which men are fitted to be the leaders and directors of their fellows in enterprises of importance to the interests of the race. But it was not by attributes of strength and power alone that the mind of Paul was characterized. The sternness of these was relieved and softened by others of a more amiable and gentle cast. A vein of tenderness and sensibility flowed through his soul, which, whilst it made him the more susceptible of suffering from ingratitude or persecution, rendered him at the same time gentle and compassionate to the feelings of others. With all his freedom from Jewish prejudices, he never lost his reverence for the country and institutions of his fathers; and with all his zeal for rectitude, and all his firmness in rebuking error, he never forgot what was due to the imperfections of his brethren, or deemed that truth could be made attractive if divorced from charity. Removed alike from the extremes of fanaticism on the one hand and apathy on the other, his whole life was a noble instance of the consecration, on sound and elevated principles, of the highest powers, and the most indefatigable energies, to a work in which he had no personal interest apart from that of his fellow Christians, and from the honour which was to accrue from his exertions to that Master whom it was his high ambition to serve in life, and his animating expectation to join at death. Apart altogether from his character as an apostle of Christ, his labours in the cause of human amelioration entitle him to veneration as one of the greatest benefactors of the species; whilst in his peculiar capacity as one of the founders of the Christian church, and an inspired expositor of divine truth, he stands without a rival in his claims upon our gratitude and reverence. His history is a standing evidence of the truth of our religion; to his labours we are indebted mainly for the rapid extension of Christianity both in the East and in the West; and in his writings are contained those treasures of heavenly doctrine which it has been the chosen occupation of some of the greatest minds of subsequent ages to explore and to unfold. With these irresistible claims, the more his life, character, and writings are studied, the deeper will be the veneration in which he will be held, and the more sincere will be the gratitude of every pious mind to the Author of all good, for having, in so remarkable a manner, supplied the church with a teacher so eminently qualified to advance its best interests, and establish, to the end of time, the faith, efficiency, and enjoyment of its members. (N. N. N. N.)

Paul, *St*, an island in the South Pacific Ocean, about 10,000 toises in circumference. Long. 75. 2. E. Lat. 37. 56. S.

Paul, first bishop of Narbonne, or Sergius Paulus the proconsul, converted and made bishop by St Paul, was descended from one of the best families of Rome.

Paul, *Father*, whose name, before he entered into the monastic state, was Peter Sarpi, was born at Venice, on the 14th of August 1552. His father followed merchandise, though with so little success, that at his death he left his family very ill provided for, but under the care of a mother whose piety was likely to bring the blessing of Providence upon them, and whose wise conduct supplied the want of fortune. Happily for young Sarpi, she had a brother, master of a celebrated school, under whose direction he was placed by her; and here he lost no time, but cultivated his abilities, which were naturally of the first rate, with unwearied application. He was born for study, having a natural aversion to pleasure and gaiety, and a memory so tenacious that he could repeat thirty verses after once hearing them. Proportional to his capacity was his progress in literature. At the age of thirteen, having made himself master of school learning, he turned his attention to philosophy and the mathematics, and entered upon logic under Capella of Cremona, who, though a celebrated master of that science, confessed that in a very little time he found himself unable to give his pupil any further instructions.

As Capella was of the order of the Servites, his scholar was induced by him to engage in the same profession, although his uncle and his mother represented to him the hardships and austerities of that kind of life, and advised him with great zeal against it. But he was steady in his resolutions, and in 1566 took the habit of the order, being then only in his fourteenth year; a time of life with most persons very improper for such engagements, but in him attended with such maturity of thought, and such a settled temper, that he never seemed to regret the choice which he then made, and afterwards confirmed it by a solemn public profession in 1572.

At a general chapter of the Servites which was held at Mantua, Paul, being then only twenty years old, distinguished himself so much in a public disputation, by his genius and learning, that William duke of Mantua, a great patron of letters, solicited the consent of his superiors to retain him at his court, and not only made him public professor of divinity in the cathedral, and reader of casuistical divinity and canon law in that city, but honoured him with many proofs of his esteem. But Father Paul finding a court life not agreeable to his temper, quitted it two years afterwards, and retired to his beloved privacy, being then not only acquainted with the Latin, Greek, Hebrew, and Chaldaic languages, but with philosophy, the mathematics, canon and civil law, all parts of natural philosophy, and chemistry itself; for his application was unintermitted, his head clear, his apprehension quick, and his memory retentive.

Being made priest at twenty-two, he was by the illustrious Cardinal Borromeo honoured with his confidence, and employed by him on many occasions, not without the envy of persons of inferior merit, who were so far exasperated as to lay a charge against him before the Inquisition, for denying that the Trinity could be proved from the first chapter of Genesis; but the accusation was too ridiculous to be entertained. After this he passed successively through the dignities of his order, and having been chosen provincial for the province of Venice at the age of twenty-six, he discharged the duties of his office with such ability, that in 1579 he was appointed, with two others, to draw up new regulations and statutes for its government. This he executed with great success; and when his office of provincial expired, he retired for three years to the study of natural and experimental philosophy and anatomy, in which he is said to have made some useful discoveries. In the intervals of his employment he applied himself to his studies with an extensive capacity, which left no branch of knowledge untouched. Acquapendente, the great anatomist, confesses that he learned from Paul how vision was performed; and there are proofs that he was not a stranger to the circulation of the blood. He frequently conversed on astronomy with mathematicians, on anatomy with surgeons, on medicine with physicians, and on the analysis of metals with chemists, not as a superficial inquirer, but as a complete master. He was next chosen procurator-general of his order; and, during his residence at Rome, he was not only greatly esteemed by Pope Sixtus V., but also contracted an intimate friendship with Cardinal Bellarmine and other eminent persons.

But the hours of repose, which he employed so well, were interrupted by a new information in the Inquisition, where a former acquaintance produced a letter written by him in ciphers, in which he said, "that he detested the court of Rome, and that no preferment was obtained there but by dishonest means." This accusation, however dangerous, was passed over on account of his great reputation; but it made such an impression on that court, that he was afterwards denied a bishopric by Clement VIII. After these difficulties were surmounted, Father Paul again retired to his solitude, where he appears to have turned his attention more to improvement in piety than to learning. Such was the care with which he read the Scriptures, that, it being his custom to draw a line under any passage which he intended more nicely to consider, there was not a single word in his New Testament but was underlined. The same marks of attention appeared in his Old Testament, Psalter, and Breviary.

But the most active scene of his life commenced about the year 1615, when Paul V., exasperated by some decrees of the senate of Venice which interfered with the alleged rights of the church, laid the whole state under an interdict. The senate, filled with indignation at this treatment, forbade the bishops to receive or publish the pope's bull; and, convening the rectors of the churches, commanded them to celebrate divine service in the accustomed manner, with which most of them readily complied; but the Jesuits and some others, having refused, were by a solemn edict expelled the state. Both parties having proceeded to extremities, employed their ablest writers to defend their measures. On the pope's side, Cardinal Bellarmine entered the lists, and, with his confederate authors, defended the papal claims with great vehemence of expression, and very sophistical reasonings; which were confuted by the Venetian apologists in much more decent language, and with greater solidity of argument. On this occasion Father Paul was eminently distinguished by his Defence of the Rights of the Supreme Magistrate, and his Treatise of Excommunication, translated from Gerson, with an Apology, and other writings. For these he was cited before the Inquisition at Rome; but it may easily be imagined that he did not obey the summons.

The Venetian writers, whatever might be the abilities of their adversaries, were at least superior to them in the justice of their cause. The propositions maintained on the side of Rome were, that the pope is invested with all the authority of heaven and earth; that all princes are his vassals, and that he may annul their laws at pleasure; that kings may appeal to him, as he is temporal monarch of the whole earth; that he can discharge subjects from their oaths of allegiance, and make it their duty to take up arms against their sovereign; that he may depose kings without any fault committed by them, if the good of the church requires it; that the clergy are exempt from all tribute to kings, and are not accountable to them even in cases of high treason; that the pope cannot err; that his decisions are to be received and obeyed on pain of sin, though all the world should judge them to be false; that the pope is the vicegerent of God upon earth; and that to call his power in question is to call in question the power of God; maxims which it did not require the abilities and learning of Father Paul to prove to be false and destructive. It may easily be imagined, that such principles were quickly overthrown, and that no court but that of Rome thought it for its interest to favour them. The pope, therefore, finding his authors confuted and his cause abandoned, was willing to terminate the affair by a treaty; which, by the mediation of Henry IV. of France, was concluded upon terms very much to the honour of the Venetians. But the defenders of the Venetian rights, though comprehended in the treaty, were excluded by the Romans from the benefit of it. Some, upon various pretences, were imprisoned; others were sent to the galleys; and all were excluded from preferment. But their malice was chiefly aimed against Father Paul, who soon felt the effects of it; for, as he was going one night to his convent, about six months after the accommodation, he was attacked by five ruffians armed with stilettoes, who gave him no less than fifteen stabs, three of which wounded him in such a manner that he was left for dead. The murderers fled for refuge to the nuncio, and were afterwards received into the pope's dominions; but they were pursued by divine justice, all, except one man who died in prison, having perished by violent deaths.

This, and other attempts upon his life, obliged him to confine himself to his convent, where he engaged in writing the History of the Council of Trent; a work unequalled for the judicious disposition of the matter, and the skilful texture of the narration. It is commended by Dr Burnet as the completest model of historical writing, and celebrated by Mr Worton as equivalent to any production of antiquity; a work in which the reader finds "liberty without licentiousness, piety without hypocrisy, freedom of speech without neglect of decency, severity without rigour, and extensive learning without ostentation."

In this, and other works of less consequence, he spent the remaining part of his life, until the beginning of the year 1622, when he was seized with a cold and fever, which he neglected till it became incurable. He languished more than twelve months, which he spent almost wholly in preparation for his passage into eternity; and amongst his prayers and aspirations he was often heard to repeat, "Lord, now let thy servant depart in peace." Throughout the whole course of his illness, to the last hour of his life, he was consulted by the senate in public affairs, and returned answers in his greatest weakness with such presence of mind as could only arise from the consciousness of innocence.

On the day of his death he had the passion of our blessed Saviour read to him out of St John's Gospel, and spoke of the mercy of the Redeemer, and his confidence in his merits. As his end approached, the brethren of his convent came to pronounce the last prayers, with which he could only join in his thoughts, being able to pronounce no more than the words *Esto perpetua*, which was understood to be a prayer for the prosperity of his country. He died in the seventy-first year of his age, hated by the Romans as their most formidable enemy, honoured by all the learned for his abilities, and esteemed by the good for his integrity.

PAULEE, or Pauleegur, a celebrated fortress and town of Hindustan, province of Aurungabad, and district of Concan. It is erected on the top of an insulated mountain, about 1500 feet in height, and is inaccessible on the north side, which is well defended. It contains several reservoirs of water, and the store-rooms and other places are hewn out of the solid rock. This extraordinary fortress was taken in 1818 by the British troops. There is another town of the same name in the province of Ajmeer, and one of the greatest commercial marts in Rajpootana, where the commodities of Europe, Persia, and the Deccan are exchanged for those of Cashmere and the northern and eastern parts of Hindustan. Paulee is also the name of a town and fortress in the south of India, province of Malabar.

PAULIANISTS, Paulianistæ, a sect of heretics, so denominated from their founder Paul of Samosata, who was elected bishop of Antioch in 262. His doctrine seems to have amounted to this, that the Son and the Holy Ghost exist in God in the same manner as the faculties of reason and activity do in man; that Christ was born a mere man, but that the reason or wisdom of the Father descended into him, and by him wrought miracles upon earth, instructing the nations; and that, on account of this union of the Divine Word with the man Jesus, Christ might be called God, though, as he conceived, improperly. It is also said that he did not baptize in the name of the Son; for which reason the council of Nice ordered those who had been baptized by him to be rebaptized.

Being condemned by Dionysius Alexandrinus in a council, he abjured his errors to avoid deposition; but he soon afterwards resumed them, and was actually deposed by another council in 269. This man may be considered as the father of the modern Socinians; and his errors were severely condemned by the council of Nice. The creed agreed upon by the Nicene fathers, with a view to the errors of Paul of Samosata, concludes thus: "But those who say there was a time when he was not, and that he was not before he was born, the catholic and apostolic church anathematizes." To those who have any veneration for the council of Nice this must appear a very severe, and perhaps not unjust, censure of some other modern sects, as well as that of the Socinians.

PAULICIANS, a branch of the ancient Manicheans, so called from their founder, Paulus, an Armenian, who lived in the seventh century, and who, with his brother John, both of Samosata, formed this sect; but others are of opinion that they were so called from another Paul, an Armenian by birth, who lived under the reign of Justinian II. In the seventh century a zealot called Constantine revived this drooping sect, which had suffered much from the violence of its adversaries, and was ready to expire under the severity of the imperial edicts, and the zeal with which these were carried into execution. The Paulicians, however, by their number, and the countenance of the Emperor Nicephorus, became formidable in all the East.

But the cruel rage of persecution, which had for some years been suspended, broke forth with redoubled violence under the reigns of Michael Curopalates and Leo the Armenian, who inflicted capital punishment upon such of the Paulicians as refused to return into the bosom of the church. The Empress Theodora, tutoress of the Emperor Michael, in 845 obliged them either to recant or to quit the empire; upon which several of them were put to death, and more retired amongst the Saracens.

Upon this they entered into a league with the Saracens; and choosing as their chief an officer of the greatest resolution and valour, whose name was Carbeus, they declared against the Greeks a war which was carried on during fifty years with the greatest exasperation and fury. During these commotions, some Paulicians spread their doctrines amongst the Bulgarians; but many of them, either from a principle of zeal for the propagation of their opinions, or from a natural desire of flying from the persecution which they suffered under the Grecian yoke, retired, about the close of the eleventh century, from Bulgaria and Thrace, and formed settlements in other countries. Their first migration was into Italy; and thence, in process of time, they sent colonies into almost all the other provinces of Europe, and formed gradually a considerable number of religious assemblies, who adhered to their doctrine. In Italy they were called *Patarini*, from a certain place called Pataria, being a part of the city of Milan, where they held their assemblies; and *Gathari* or *Gazari*, from Gazaria, or the Lesser Tartary. In France they were called *Albigenses*, and anxiously concealed their more obnoxious doctrines. The first religious assembly which the Paulicians had formed in Europe is said to have been discovered at Orleans in 1017, under the reign of Robert, when many of them were condemned to be burned alive. The ancient Paulicians, according to Photius, expressed the utmost abhorrence of Manes and his doctrine; but it is nevertheless certain that their successors were Manicheans. The Greek writers comprise their errors under the six following heads. They denied that this inferior and visible world is the production of the Supreme Being, distinguishing the Creator of the world and of human bodies from the Most High God who dwells in the heavens; they treated contemptuously the Virgin Mary; they refused to celebrate the institution of the Lord's Supper; they loaded the cross of Christ with contempt and reproach; they rejected the books of the Old Testament, and looked upon the writers of that sacred history as inspired by the Creator of this world, and not by the Supreme God; and they excluded presbyters and elders from all share in the administration of the church.

PAULINUS, a bishop who flourished in the early part of the seventh century. He was the apostle of Yorkshire, and the first archbishop of York. This dignity seems to have been conferred upon him about the year 626. He built a church at Almonbury, which he dedicated to St Alban, and there he preached to and converted the Brigantes. Camden mentions a cross at Dewsborough, which had been erected to him, with this inscription, "Paulinus hic prædicavit et celebravit." About this time York was so small that there was not so much as a church in it in which King Edwin could be baptized. Constantius is said to have made it a bishopric; and Pope Honorius erected it into a metropolitan see. We are told that Paulinus baptized in the river Swale, in one day, ten thousand men, besides women and children, on the first conversion of the Saxons to Christianity. At Walstone, in Northumberland, he baptized Segbert king of the East Saxons. Bede says, "Paulinus coming with the king and queen to the royal manor called *Ad Gebdrin* (now Yeverin), staid there thirty-six days with them, employed in the duties of catechizing and baptizing. In all this time he did nothing from morning to night but instruct the people, who flocked to him from all the villages and places, in the doctrine of Christ and salvation; and, after they were instructed, he baptized them in the neighbouring river Glen." According to the same venerable author, "he preached the word in the province of Lindissi; and first converted the governor of the city of Lindocollina, whose name was Blecca, with all his family. In this city he built a stone church of exquisite workmanship, whose roof being ruined by long neglect or the violence of the enemy, only the walls are now standing." He is also said to have founded a collegiate church of prebends near Southwell, in Nottinghamshire, dedicated to the Virgin Mary. This church he is stated to have built when he baptized the Coritani in the Trent.

PAULO, Marco, a celebrated traveller, was son of Nicholas Paulo, a Venetian, who, with his brother Matthew, about the year 1255, visited Constantinople, in the reign of Baldwin II. Nicholas, at his departure, left his wife pregnant; and she brought to the world the famous Marco Paulo, the subject of this notice. The two Venetians, having taken leave of the emperor, crossed the Black Sea, and travelled into Armenia, whence they passed over land to the court of Barka, one of the greatest lords of Tartary, who loaded them with honours. This prince having been defeated by one of his neighbours, Nicholas and Matthew made the best of their way through the deserts, and arrived at the city where resided Kublai, khan of the Tartars. Kublai was entertained with the account which they gave him of the European manners and customs; and appointed them ambassadors to the pope, in order to demand of his holiness a hundred missionaries. They accordingly returned to Italy, obtained from the pontiff two Dominicans, the one an Italian and the other an Asiatic, and carried along with them young Marco, for whom Kublai expressed a singular affection. This young man, having learned the different dialects of Tartary, was employed in embassies which gave him the opportunity of traversing Tartary, China, and other eastern countries. At length, after a residence of seventeen years at the court of the khan, the three Venetians returned to their own country, in the year 1295, with immense fortunes. A short time after his return, Marco, serving his country at sea against the Genoese, lost his galley, in a great naval engagement, and was himself taken prisoner and carried to Genoa. He remained there many years in confinement; and, to amuse his melancholy as well as to gratify his friends, he sent for his notes from Venice, and composed the history of his own and his father's voyages in Italian, under this title, *Delle Maraviglie del Mondo da lui vidute;* the first edition of which appeared at Venice in 1496, in 8vo. His work was translated into different languages, and inserted in various collections. The editions most esteemed are the Latin one published by Andrew Muller at Cologne, 1671, in 4to, and that in French, to be found in the collection of voyages published by Bergeron, at the Hague, 1735, in two vols. 4to. In the writings of Marco Paulo there are some things true, and others highly incredible. It is indeed difficult to believe, that as soon as the khan was informed of the arrival of the two Venetian merchants, who were come to sell theriaca, or treacle, at his court, he sent before them an escort of forty thousand men, and afterwards despatched these Venetian ambassadors to the pope, to beseech his holiness to send him a hundred missionaries. It is equally difficult to believe that the pope, who doubtless had an ardent zeal for the propagation of the faith, should, instead of a hundred, have sent him only two missionaries. There are, therefore, some errors and exaggerations in Marco Paulo's narrative; but many other things which were afterwards verified, and which have been of no little service to succeeding travellers, prove that in several respects his relation is valuable. He not only gave better accounts of China than had before been received, but likewise furnished a description of Japan, of many of the islands of the East Indies, of Madagascar, and of the coasts of Africa; so that from his work it might be easily collected, that a direct passage by sea to the Indies was not only possible, but practicable. It may be worth while to add, that, in the opinion of the authors of the Universal History, what he wrote down from his own knowledge is both curious and true; so that where he has erred, his father and uncle must have deceived him.

PAULO, San, a large and important province of Brazil, in South America, celebrated for the courage of its inhabitants, and for the number of expeditions which have sailed from it for the purpose of exploring the interior. It is formed by the union of a part of the old capitanship of St Amaro with half of that of St Vincente, and received its present name in the year 1710, when John V., having incorporated them with the crown-lands by purchase, appointed the city of St Paulo as the residence of the captain-general. It is separated from the province of Rio de Janeiro on the north-east by a line which, traversing the heights of the vast serra from the point of Joatinga to the head of the Jacuy, descends that river till it joins the Paraiba. The Serra do Montequeira interposes between it and Minas Geraes on the north, the Rio Grande and the Parana separate it from Poyaz and Matto Grosso on the west and north-west, the Saha from St Catherina on the south, and for its eastern boundary it has the Atlantic Ocean. Its territory is almost all within the temperate zone, between 20.30. and 28.0. of south latitude, measuring 450 miles from north to south, and having a medium breadth of 340 miles. St Paulo is divided into three comarcas or ouvidorias, viz. St Paulo, Hitu, and Curytiba, each called after the principal town situated in it. Excepting on the eastern part, where a cordillera or elevated ridge of mountains runs parallel with the coast, this province is not mountainous. With the exception of Para, not one of the maritime provinces contains so many navigable rivers as St Paulo; but, unfortunately, all these flow into the interior, and are absorbed by the mighty Parana, so that they do not in any way facilitate intercourse with the coast. The few streams or mountain torrents which descend the eastern declivity of the cordillera, and fall into the Atlantic, are of no use in a commercial point of view, not being navigable. This province, like most others of Brazil, abounds in large forests, the trees being such as are common to the country. These are succeeded by plains and gently rising hills, covered with scattered bushes, and extensive tracts of verdure, which form by far the largest proportion of its surface; and hence St Paulo is pre-eminently adapted for the breeding of cattle, vast herds of which everywhere abound. Oxen, horses, and mules thrive exceedingly well, and are particularly numerous. Sheep are not attended to; but here there is a very fine and large breed of goats, whose milk is generally used. The soil of this province is in many parts very rich, and the vegetable productions are numerous and luxuriant. The articles chiefly cultivated are wheat, rye, maize, manioc, rice, and potatoes; and lately the vine has been introduced with perfect success. The palma Christi grows in such abundance that castor oil is burned in lamps instead of spermaceti. Cotton and coffee do not appear to thrive very well, and the sugar-cane but indifferently; yet rum is made in quantities sufficient to supply the home consumption of that article. Little mandioc is cultivated, but maize is raised to a great extent, and considerable quantities of it are sent to Rio. In some parts this grain, and also rice, yield two hundred and fifty fold; an extraordinary return, when we consider that in England the produce of wheat is only as twelve to one. The mulberry tree attains to great perfection in this climate, and the silk-worms are said to produce a very beautiful thread, so that the culture of silk might be carried on with great success. The cochineal insect is also found in many parts of the province, and might be made to furnish an equally profitable branch of trade. But the aversion of the Paulistas to laborious work, as long as they can obtain the rich gifts of nature without much trouble, has hitherto prevented this branch of industry from being prosecuted. The jasmine is here a favourite tree, and bears flowers perennially, as does also the rose. Bees are by no means uncommon; and although insects are numerous, the mosquito is less troublesome than in Rio or La Plata.

The bulk of the inhabitants of St Paulo are graziers, the breeding of cattle being the chief occupation. The vast grassy campos, which extend over the surface of the province, afford every facility for prosecuting it upon a great scale; and, by the following extract from the valuable work of Dr Von Spix, it will be seen that the Paulistas take every advantage of their situation. "Every landholder possesses, according to the extent of his farm, from several hundred to two thousand, nay, even forty thousand, head of cattle. They generally reckon from three to four thousand head on an estate which has two square miles of good pasture. All these roam at liberty in a wild state; but every farmer keeps, besides, as many tame draught oxen and cows as he requires for the purposes of agriculture and milk, which is partly made into cheese. The attendance on the wild cattle gives but very little trouble; all that is required is to brand them with the mark of the owner, and to catch the animals intended to be slaughtered. From four to six servants, under the direction of a chief cowherd, perform all these services; they prevent the herds from straying beyond the boundaries, and defend them from the attacks of the ounces, wolves, and wild dogs. These people are almost always on horseback, as their office compels them to ride twenty miles or more in a day. Every year the whole herd is collected at different times in a place in a high situation, and sometimes fenced in. On this occasion the mark of the owner is branded on the hind quarter of the beasts one year old, of which they reckon a thousand annually for a herd of five or six thousand. Those of four years old or more are selected for slaughter." The hide is always the most valuable part of the cattle; but the flesh also, after being salted, is exported in great quantities to the cities of the north. The breeding of horses and mules likewise occupies the attention of the farmers of St Paulo. The horses of this province are of a middling size, of slender make, and, if they are attended with care, acquire an elegant carriage, and become excellent racers. In general twenty or thirty of these wild horses herd together, and hardly ever separate. Both they and the wild cattle are captured, as in the pampas of Buenos Ayres, by long leathern nooses, which, Mr Mawe informs us, the Paulistas use with incredible dexterity. The mules here are more handsomely formed animals than the horses. They are commonly equal in size to the European horse; and their colours are black, brown, fallow, or they are striped like the zebra. They are preferable to the horses, especially on long journeys, as they can endure hunger and thirst much longer, and carry heavier burdens with much greater security.

The working of the gold and iron mines of St Paulo is the next branch of the industry of the province which requires to be noticed. The celebrated gold-mines of Jaragua are situated about twenty-four miles from the capital of the province. They were the first discovered in this country, and, on account of the immense treasures which they produced above a century ago, this district was regarded as the Pasco of Brazil. After having been abandoned for some time, the gold-washing had been resumed at the period of Dr Von Spix's visit in 1818. The mountain of Jaragua is one of the most southerly branches of the Serra do Montequeira, which, after running for more than fifty miles to the north, disappears in this latitude. The rock is granite, sometimes gneiss, containing a portion of hornblende with mica. The earth washed for gold Dr Spix describes as "a ferruginous sandstone conglomerate. The soil is red and remarkably ferruginous. The gold lies for the most part in a stratum of rounded pebbles and gravel, called cascalhao, incumbent on the solid rock. In the valleys where there is water occur frequent excavations made by the gold-washers, some of them fifty or a hundred feet wide, and eighteen or twenty feet deep. On many of the hills, where water can be collected for washing, particles of gold are found in the soil, scarcely deeper than the roots of the grass." The gold is obtained by the usual process of washing with water, negroes being chiefly employed in the operation. The pursuit of this precious metal has now much declined in St Paulo, the gold-hunters finding a richer harvest in the provinces of Minas Geraes and Matto Grosso.

In the mountain of Guarassojava, situated about twenty leagues from St Paulo, the capital city of the province, there are vast mines of magnetic ironstone; and a foundery for obtaining the metal has been erected on the banks of the Ypanema or Hipaunema, round which a small village has grown up. The mines were never regularly worked until 1810, when a company of Swedish miners were brought to the spot, and erected two small furnaces. In 1818 a handsome and extensive edifice was built, with every necessary convenience for the miners. Operations then commenced with considerable vigour; but as the wood in the neighbouring forests is the only kind of fuel of which they have any command, Dr Spix anticipates that a want of this indispensable article will by and by be experienced. The ore appears to be very rich, some of it containing ninety per cent.; and it exists in such incredible abundance, that Dr Spix thinks St Paulo might supply not only Brazil, but all the rest of the American continent, with that metal, if exportation were only facilitated by making a proper road or canal to the coast. The mountain which produces this extraordinary quantity of ore rises behind the neat little town of St João de Ypanema, a quarter of a mile to the west, and extends, as a rather insulated mountain ridge, a league in length from south to north. The mass of magnetic ironstone is either compact or traversed by veins of red ochre. The surface of the masses of rock, which rise nearly perpendicularly to the height of forty feet and more, is almost everywhere flat and even, with slight depressions and cavities, and has a crust of imperfectly oxidated ironstone. Dr Spix informs us that he did not observe that the great masses caused any motion in a suspended needle; but small pieces, especially when just struck off, had a considerable effect on it.

The city of St Paulo, from which the province derives its name, is the most ancient in Brazil, and, beyond every other, interesting in an historical point of view. "Here, more than in any other place," says Dr Spix, "we find the present connected with the past. The Paulista is sensible of this, and says, not without pride, that his native city has a history of its own." It is situated at the angle of the confluence of the Tamandatahi, which washes it on the west, with the Hynhangabahu, which flows on the eastern side. The celebrated Anchieta and his brother Jesuits commenced this city in the year 1552, with the foundation of a college, in which they celebrated the first mass on St Paul's day; and when, six years afterwards, it acquired the denomination of a town, its name was determined by this circumstance. Its first inhabitants were Indians, but they were soon joined by Europeans in great numbers, and a mixed race rapidly augmented the population; so that, before a century had elapsed, the Paulistas had become as formidable by their numbers as they were distinguished by their spirit of enterprise. Their love of travelling, and the hope of discovering the treasures of the New World, prevented them from cultivating their own fertile territory. They visited almost every part of Brazil. They crossed lofty mountains, until then deemed impassable. They were not checked by rivers, deserts, nor savage men, who waged perpetual war against them. The richest mines of Brazil were discovered by the Paulistas, who abandoned them with regret, and reluctantly submitted to the authority of their government. But this ardour of enterprise also led to serious evils. The early historians describe them as a lawless tribe, who had shaken off the yoke of Portugal, and constituted themselves a separate republic. They certainly acted in many instances in a perfectly independent manner, making incursions into the neighbouring countries, and committing the most dreadful barbarities. Paraguay suffered severely by these inroads, and the missions which had been formed in that country were at one time nearly ruined by the Paulistas. (See the article PARAGUAY.) The selfish rudeness and insensibility which formerly distinguished the Paulista is now much softened; and, although pride, revenge, and stubbornness are still recognised as forming part of his character, he enjoys throughout Brazil the reputation of great frankness, undaunted courage, and a romantic love of adventures and dangers.

The city of St Paulo is well laid out on an eminence of about two miles in extent, and rising about fifty feet above the wide plain of Pirantininga. Placed exactly at the angle formed by the confluence of the rivers Tamandatahi and Hynhangabahu, the former washes it on the western, and the latter flows past its eastern side. The streets are broad, light, and cleanly; and some of them are well paved, with a material in which particles of gold are found after a heavy rain has searched the chinks and hollows. The houses in the principal streets are two or three stories in height, stuccoed in various colours, and frequently having latticed balconies. The walls are erected by means of a framework made of wood, into which earth is put, which the workmen heat and occasionally moisten with water, until it acquires solidity. These houses of earth appear to be very durable, for Mr Mawe mentions that he saw some which had lasted two centuries. The residence of the governor, formerly the Jesuits' College, is built in a very good style, but has fallen into decay. The episcopal palace and the Carmelite convent are large and stately edifices, and the cathedral and some of the churches are spacious. The city is divided into two parishes; that of the Cathedral, and that of the Church of St Efigenia. Besides the public buildings already mentioned, St Paulo contains several chapels, monasteries, and nunneries, and three hospitals. Few manufactures of any consequence are carried on. A little coarse cotton is spun by the hand, and woven into cloth, which serves for a variety of purposes. By the most recent accounts which we have received, the manufactures are said to be improving. There is made here a beautiful kind of network for hammocks, which are fringed with lace, and form an elegant piece of furniture. The making of lace is a general employment for females, some of whom excel in it. Shopkeepers are a very numerous class here, and various trades are prosecuted with considerable spirit. A coarse earthenware is made at the outskirts of the city; but the great proportion of the inhabitants are farmers and inferior husbandmen, who cultivate small portions of land, on which they breed large stocks of pigs and poultry for sale. With these the market is generally well supplied, and also with various kinds of fruit and vegetables. St Paulo is esteemed a most healthy situation; and the climate, Dr Spix says, is one of the most agreeable in the world. Its situation, almost under the tropic of Capricorn, as well as its elevation of 1200 feet above the surface of the sea at Santos, imparts to the city all the charms of a tropical climate, without any great inconvenience from heat. The thermometer ranges from 50° to 80° of Fahrenheit. The population, including the dependent parishes, was estimated, Dr Spix says, at above 30,000 souls, of which one half were whites, or those who were reckoned such, and one half were people of colour. Henderson, in his history of Brazil, states the population as being from 35,000 to 40,000; but an official return for 1815 fixes the population of the city at 25,313 souls, of whom 12,274 were whites, 845 free blacks, 6239 free mulattoes, and 5955 slaves. The number of inhabitants must have considerably increased since the date of the above census, and, in the absence of official reports, we probably do not over-estimate the population in 1838 at 40,000. In general the principal characteristics of the Paulistas are, a lofty, and, at the same time, broad make; strongly-marked features, expressive of a bold, independent spirit; with eyes full of fire, and motions indicative of great vivacity. They are considered as the strongest, most healthy, and most active inhabitants of the country; and "the appellation of Paulista," says Mr Mawe, "is considered by all the females here as a great honour, the Paulistas being celebrated throughout Brazil for their attractions and their dignity of character." The city of St Paulo stands in lat. 23. 33. 10. south, and long. 46. 39. 10. west from Greenwich.

Santos is the only harbour in the province which has a direct intercourse with Europe; but, although no more than twelve leagues distant from the capital, the want of water communication, and the difficult nature of the road between the two cities, render the transport of goods a matter of considerable labour and expense. The road from Santos to St Paulo is cut in many places through solid rocks, and in others along the edge of precipices, which are fenced by parapets, otherwise the traveller might be in danger of falling into an impervious thicket more than thirty yards below him. Some fine springs, issuing from elevated sources, form romantic cascades in the midst of detached rocks. In these places the rocks consist of granite, and soft ferruginous sandstone, but everywhere else the mountains are covered with thick woods; even on the road branches of trees meet and form arbours, that defend the traveller from the rain, and shelter him from the heat of the sun. There are two other seaports, but they are situated at a much greater distance from St Paulo, and both are inconsiderable. The harbour of Santos has a safe entrance, and is very secure. It is a strait, having the island of St Vincente to the left, for the extent of half a mile, when it takes a different direction. Here is situated the port, which has good anchorage and regular soundings along the shore, and is the resort of many vessels trading to the Plata. Hides and tallow are the principal articles of export, and sugar, coffee, and some European articles are received in return. Its intercourse with the capital is carried on by means of mules, which come laden with the produce of the interior, and carry back salt, earthenwares, cutlery, and other goods from Europe. Santos is tolerably well built, most of the houses being of stone, and very ancient. The situation is by no means healthy, as the country around is low, woody, and frequently deluged with rain. The rice of this district, which is raised in great quantities, is esteemed the best in Brazil, and the bananas are equally celebrated. The population, consisting chiefly of merchants, shopkeepers, and artificers, amounts to about 7000. Not far to the north of Santos Bay is the fine island of St Sebastian, which is above twenty miles in length. It is very fertile, and is reputed to produce the best sugar, rum, and tobacco, as well as the finest cattle, in all Brazil. There is a town situated on it; and opposite the island, on the mainland, is St Sebastian, formerly of some note, but now reduced to 2000 or 3000 inhabitants.

Amongst the other towns of St Paulo is Sorocaba, a flourishing place, situated on a small river of the same name which flows into the Tiete, one of the tributaries of the Parana. It is a great thoroughfare and market for mules from Rio Grande do Sul; above thirty thousand of which, it is reckoned, pass through Sorocaba annually. The population may be between five and six thousand, two thirds of the whole being whites. Sorocaba is situated in the comarca of Hitu, sixty miles west from the capital. Eighteen miles to the north-west is Hitu or Ytu, the chief town of the comarca to which it gives name. It is situated at the foot of the hills, and is excessively hot in the summer months. The soil in the neighbourhood is said to be well adapted to the culture of the sugar-cane; but it does not appear that any advantage is taken of this circumstance. There are several other towns in the comarca, but none of them of any importance.

The comarca of Curutiba is situated in the southern part of the province, and is generally mountainous on the coast, but expands inland into beautiful and salubrious campos. Mr Mawe speaks of these elevated plains as the finest district in the country, and indeed one of the finest in the world, in point of climate. Its soil and air are so excellent, that olives, grapes, apples, peaches, and other fruits grow to as great maturity as in Europe, though they are here almost in a wild state. Curutiba, the principal town, is stated to have a magnificent church; all its structures are of stone or brick, and the streets are paved. The district abounds in pine forests; hence its name *curu*, pine, and *tiba*, many; and the cedar is also common in many parts. These forests abound with the mountain hog, herds of which may be met with to the number sometimes of a hundred or more.

The Curutibanos, who are very robust, are chiefly employed in breeding cattle, horses, and mules; but they also cultivate the ground. Paranagua, which, prior to the year 1812, was the seat of the provincial magistracy, like Curutiba, is built of stone, and stands on the southern bank of the river from which it derives its name, about ten miles from the sea. The other villas of this comarca are Villa Vovade St Luis, or Guaratuba, seven miles from the sea; Antonio, ten miles west of Paranagua, at the extremity of the bay of that name; Cannanca, situated upon a small island, about ten miles within the bar of the river of the same name; and several others, including Nossa Senhora dos Prazeres, the most southern town in the province, and much infested by the savages. The Indians have still some villages, in which they live in a half-civilized state, making occasional predatory attacks on the plantations and cattle of their neighbours. On the other hand, numbers have become civilized, and reside peaceably in settlements by themselves, imitating the manners and customs of the European or Creole part of the population. The only town of importance which remains to be noticed is Taubaté, a considerable place, and rivalling the capital in antiquity. It is reckoned about a hundred miles north-east from St Paulo. In former times, when the thirst for gold was at its height amongst the Paulistas, a government establishment for the refining of the metal was founded here; and the rivalry between the Taubatenos and the Paulistas of Piratininga, rose to a rancorous and implacable feud, and many sanguinary conflicts were the consequences of this enmity, traces of which are said to exist at the present day, although gold-washing is no longer pursued at Taubaté.

According to official reports, dated in 1815, the population of the whole province then amounted to 215,021 souls. By a previous census for the year 1808, the number was 200,478, which shows an increase of nearly fifteen thousand in seven years. The population in 1830 was said to be 610,000 souls. Considering the size of the province, its vegetable wealth, and the number of its inhabitants, the trade which it carries on is comparatively small, and the proportion of pecuniary wealth in it is inferior to that of the more northern provinces. The chief articles of export are sugars, rice, hides, and Peruvian bark. (R. R. R.)

PAULUS ÆMILIUS. See ÆMILIUS, PAULUS.

PAUNGAOW, a small walled town belonging to the Mahrattas, in the province of Aurungabad, eighty-eight miles south-east from Ahmednagur. Long. 76. 12. E. Lat. 18. 14. N.

PAUSANIA, in Grecian antiquity, a festival with solemn games, in which nobody contended except free-born Spartans. They were instituted in honour of Pausanias the Spartan general, under whom the Greeks overcame the Persians in the famous battle of Platæa.

PAUSANIAS, a Spartan king and general, who signalized himself at the battle of Platæa against the Persians. The Greeks, sensible of his services, rewarded his merit with a tenth of the spoils taken from the Persians. He was afterwards appointed to command the Spartan armies, and he extended his conquests in Asia; but the haughtiness of his behaviour created him many enemies; and the Athenians soon obtained a superiority in the affairs of Greece. Pausanias, dissatisfied with his countrymen, offered to betray Greece to the Persians, if he received in marriage, as the reward of his perfidy, the daughter of their king. His intrigues being discovered by the Ephori of Sparta, he fled for safety to a temple of Minerva; and as the sanctity of the place screened him from the violence of his pursuers, the sacred building was surrounded with heaps of stones, the first of which was carried there by the indignant mother of the unhappy man. He was starved to death in the temple, and died about 474 years before the Christian era.

PAUSANIAS, a very celebrated antiquary, who is believed by Fabricius to be the same mentioned by Philostratus, in his Lives of the Sophists (ii. 13), as a native of Cæsareia ad Argæum, in Cappadocia, was the disciple of Herodes Atticus, and spent the greater part of his life at Rome, where he died at an advanced age. Siebelis, however, in the preface to his valuable edition of the works of Pausanias, remarks that this supposition respecting the place of his birth does not agree with what may be inferred from his own statements. In one passage (v. 13, 4) he seems to speak of Lydia as his native province; and though he frequently alludes to Herodes Atticus, he never speaks of him as his master, which he would scarcely have failed to do if he had owed any part of his education to him. Besides, Philostratus and Suidas are both silent in respect to the work upon Grecian Antiquities which has come down to us; and such an omission is a strong proof that they were not the same individual. The exact period of his birth and death is unknown, but he was employed on a part of his work in the reign of Hadrian, who died A. D. 139, and was writing the Antiquities of Elis A. D. 174, in the fourteenth year of the reign of M. Aurelius (v. 1, 1). He must thus have been contemporary with Aulus Gellius, Ptolemy the geographer, Fronto the philosopher, Apuleius, and Lucian, though his pursuits were not likely to bring him in contact with any of them.

The work which he has left is entitled Τῆς Ἑλλαδος Πεϱιηγησις, The Description of Greece, and is divided into ten books, containing an account of the antiquities in each of the provinces of Greece, in the following order: Attica, Corinthiaca, Laconica, Messeniaca, two books entitled Eliaca, Achaïca, Arcadica, Bœotica, and Phocica. He must have examined minutely every part of these provinces; and it is observed by Sir John Hobhouse, in his Journey through Albania, "that the exact conformity of present appearances with the minute descriptions of the itinerary is no less surprising than satisfactory." He evidently took every means in his power to be accurate in his descriptions, as he constantly refers, as a corroboration of his statements, to inscriptions on ancient monuments and works of art, and to gifts dedicated in the temples of the gods. Poets and historians also furnished him with materials to illustrate the antiquities of the places he visited. He is accused, however, like the Latin historian Livy, of credulity, and of narrating many stories which have no pretension to credibility. But, aware that such an accusation might be brought against him, he states (vi. 3, 4) that he thought himself bound to give these traditions of the Greeks, though there was no reason why he should believe them. In his style he is thought to have imitated Herodotus, but it is by no means successful.

The Greek text of Pausanias was first published at Venice in 1516 by Aldus, who was assisted by Musurus; but this edition, which is in folio, is very incorrect, having been printed from a bad manuscript. That of Francfort, 1583, in folio, reprinted at Hanau in 1613, and that of Leipzig, 1696, in folio, published by Kuhn, are accompanied by the Latin translation of Amaseo, which had appeared separately, Florence, 1551, in two volumes. This version, more elegant, but less faithful, than that of Loescher, published without the Greek text, by Oporin, forms the fourth volume of the edition published at Leipzig by Facius, 1794-1797, in four volumes 8vo., the first in which an attempt was made to collate the text with the manuscripts. The edition of Schœfer, Leipzig, 1818, in three small volumes, contains only the Greek. But that of Clavier, Paris, 1814-1821, in six volumes 8vo., is preferable to both these, notwithstanding the numerous typographical errors by which it is deformed; and it is accompanied by a new French translation. It is only necessary further to indicate the Italian translation of Bonaccinoli, Mantua, 1597, in 4to; and that which appeared at Rome 1792–1793, in five volumes 4to; the English translation of Taylor, London, 1793-1794, in three volumes 8vo; and the German translation of Goldhagen, Berlin, 1798, in two volumes 8vo.

PAUSE, a stop or cessation in speaking, singing, playing, or the like. One use of pointing in grammar is to make proper pauses in certain places.

PAUW, Cornelius de, sometimes called Nicolas, a moral philosopher and historian, born at Amsterdam in 1739. He is better known as the uncle of the revolutionist Anacharsis Clootz, than by the ancestors from whom he was descended; they are, however, reported by his nephew to have distinguished themselves in the revolutions of Holland in the sixteenth century.

It appears, from the same authority, that his name was Cornelius, and not Nicolas, but that he was not related to Cornelius de Pauw, the critic and the rival of Dorville; and that it was upon the marriage of his sister to Clootz's father that he obtained, through the interest of his brother-in-law, a Catholic canonicate at Xanten, in the territory of Cleves. He was afterwards appointed reader to Frederic king of Prussia, perhaps as an advocate of the new doctrines and principles which that sovereign was disposed to patronize; but he is said to have declined the offer of the place of an academician of Berlin, and a bishopric at Breslau. His attacks on the Jesuits, whom he accused of gross misrepresentation and exaggeration in their historical and geographical memoirs, rendered him unpopular with the Catholic clergy, though his learning and talents commanded a certain portion of their respect. He was simple in his manners, and somewhat negligent of his appearance. The close of his life was embittered by a tedious and painful disease; and he died on the 7th of July 1799.

His principal publications are, 1. Recherches sur les Américains, Berlin, 1770 and 1772, in 8vo; a work intended to show the "degraded state of the savage Americans," and forming a contrast to the speculations of some contemporary writers of celebrity: 2. Défense des Recherches, Berlin, 1771, 8vo: 3. Recherches sur les Egyptiens et les Chinois, Berlin, 1774, in two vols. 8vo; Philosophical Dissertations on the Egyptians and Chinese, translated by Captain J. Thomson, London, 1795, in two vols. 8vo. The investigation was undertaken, he observes, to show that "no two nations ever resembled each other less than the Egyptians and the Chinese;" and it must be admitted that he has sufficiently established his proposition. There is, indeed, one argument that he has employed, which appears to be founded on a mistake of the Greek historians of Egypt, who have asserted that the Egyptians had long been in the use of alphabetical characters; and the want of any alphabet amongst the Chinese is stated by M. de Pauw as affording a marked distinction from the Egyptians. There is, however, scarcely a shadow of resemblance in the particular hieroglyphical characters employed by the two nations, although the general system of beginning with a representation of a visible object, and departing, more and more, by degrees, from the fidelity of the delineation, must necessarily have been common to both. But it so happens, that out of about seventy Egyptian characters, which are compared by the Jesuits and Dr Morton with the Chinese in the Philosophical Transactions for 1769, there are about twenty of which the sense has been ascertained with tolerable accuracy by Dr Young; and of these there is only one that happens to have been rightly determined by the comparison with the Chinese, excepting two or three which are obviously mere pictures, as the moon and a bow. There is also amongst the old Chinese characters a figure of a chain, which agrees remarkably in its form with the Egyptian hieroglyphic employed as a copulative conjunction; but there is a still more striking coincidence, which M. Jomard has noticed, between the Egyptian and Chinese characters for a thousand, both of which he derives from the seed-vessel of the lotus, as containing a multitude of seeds; and if the older Chinese characters be found to preserve this resemblance as perfectly as they ought to do, it must be confessed that the suspicion of a common origin will be much strengthened by the argument. Both the Egyptians and the Chinese were condemned, M. de Pauw observes, "to an eternal mediocrity;" and the weight of this observation is certainly not diminished by any thing that has been inferred from the study of the hieroglyphics of the Rosetta stone and other monuments.

There are several papers of M. de Pauw on antiquarian subjects in the Memoirs of the Society of Cassel, and in particular one on the Temple of Juno Lacinia, vol. i. 1780. Recherches sur les Grècs were published at Berlin, 1787, in two vols. 8vo; Philosophical Dissertations on the Greeks, translated by Thomson, London, 1793, in two vols. 8vo. This work is principally devoted to the Athenians, amongst whom their boasted liberty is shown to have been confined to a very small number of citizens, who tyrannized over the rest of the inhabitants of their country. The Lacedæmonians, the Ætolians, the Thessalians, and the Arcadians, are separately discussed, but considered as comparatively contemptible; the Lacedæmonians in particular, and their successors the Mainotes, are treated with great severity, as a worthless race of dishonourable vagabonds. The athletic education of the Athenians is, however, highly applauded, from a visionary theory of the importance of the physical perfection of the body to the operations of the mind. An edition of the author's three principal works appeared at Paris, in seven volumes octavo, 1795. (See Dorsch, *Chardon-Larochette*, and Clootz, *Magaz. Encycl.* 1799; An. V. vol. ii. Widdigen, *Westph. Nationalk.* 1801, p. 215; *N. Allg. T. Bibl.* lxxiv. p. 77; Denina, *Prusse Littéraire*, iii. *N. Dict. Hist.* ix. 8vo, Par. 1804; Chalmers's *Biographical Dictionary*, xxiii. 8vo, Lond. 1815.) (L. L.)

PAVAN, or Pavane, a grave dance used amongst the Spaniards, and borrowed from them, in which the performers made a kind of wheel or tail before each other, like that of *pavo*, a peacock; from which circumstance the name is derived. The pavane was formerly in great repute, and was danced by gentlemen with cap and sword, by those of the long robe in their gowns, by princes with their mantles, and by the ladies with their trains trailing on the ground. It was called the *grand ball*, from the solemnity with which it was performed.

PAVIA, a province or delegation of the Austrian territory of Milan, in Italy, bounded on the north by Milan, on the east by Lodi, on the south by Parma and Sardinia, and on the west by Sardinia. It extends over 495 square miles, comprising, besides the capital, eight market-towns, and 183 villages, with 168,500 inhabitants. It is a very level district, drained by the river Po, and by the smaller streams of the Ticino, Lambro, and Olona. It is well cultivated, and, besides the common grain, produces much rice and maize, with some silk.

Pavia, a city of the Austro-Italian dominions, the capital of the delegation of the same name. It stands on the river Ticino, over which there is a marble bridge of seven arches. It has been fortified, but is now scarcely defensible. It is the see of a bishop, and, besides the cathedral, contains eighteen churches. It has a university furnished with a library of 33,000 volumes, a botanic garden, an anatomical theatre, a laboratory, and a physical museum. The professors are thirty-three, and the pupils from seven to eight hundred. It has some trade in silk, and in the other productions of the soil in its vicinity. It contains 1830 houses, and 23,800 inhabitants. Long. 9. 4. 18. E. Lat. 45. 10. 7. N.

PAVILION, in *Architecture*, signifies a kind of turret or building, usually insulated, and contained under a single roof, sometimes square, and sometimes in form of a dome;

and it is so called from the resemblance of its roof to a tent. Pavilions are sometimes projecting pieces in the front of a building, marking the middle of it; but sometimes the pavilion flanks a corner, in which case it is called an angular pavilion. The Louvre is flanked with four pavilions. These are usually higher than the rest of the building. Pavilions built in gardens are commonly called summer-houses, pleasure-houses, and the like. Some castles or forts consist only of a single pavilion.

Pavilion, in military affairs, signifies a tent raised upon posts to lodge in during the summer time.

Pavilion is also sometimes applied to flags, colours, ensigns, standards, banners, and the like.

Pavilion, in *Heraldry*, denotes a covering in the form of a tent, which invests or wraps up the armories of different kings and sovereigns, depending only upon God and their sword. The pavilion consists of two parts; the top, which is the chapeau or coronet, and the curtain, which forms the mantle. According to the French heralds, none but sovereign princes may bear the pavilion entire and in all its parts. Those who are elective, or have any dependence, say the heralds, must take off the head, and retain nothing but the curtains.

Pavilions, amongst jewellers, are the under-sides and corners of the brilliants, lying between the girdle and the collet.

PAVING, the construction of ground-floors, streets, or highways, in such a manner that they may be conveniently walked upon. In Great Britain the pavement of the streets and roads usually consists of flint or rubble-stone; but courts, stables, kitchens, halls, churches, and the like, are paved with tiles, bricks, flags, or fire-stone, and sometimes with a kind of freestone or ragstone.

Pavements of churches frequently consist of stones of several colours, but chiefly black and white, and of several forms, but chiefly squares and lozenges, artfully disposed. Indeed there needs no great variety of colours to produce a surprising diversity of figures and arrangements. M. Truchet, in the Memoirs of the French Academy, has shown by the rules of combination, that two square stones, divided diagonally into two colours, may be joined together chequerwise in sixty-four different ways; which appears surprising enough, since two letters or figures can only be combined two ways. The reason is, that letters only change their situation with regard to the first and second, the top and bottom remaining the same; but in the arrangement of these stones, each admits of four several situations, in every one of which the other square may be changed sixteen times, which gives sixty-four combinations. Indeed, from a further examination of these sixty-four combinations, he found that there were only thirty-two different figures, each figure being repeated twice in the same situation, though in a different combination, so that the two differed from each other only in the transposition of the dark and the light parts.

PAVO, in *Astronomy*, a constellation in the southern hemisphere, unknown to the ancients, and not visible in our latitude.

PAVOR, a Roman deity, whose worship was introduced by Tullus Hostilius. The latter, in a panic, vowed a shrine to him and one to Pallor, *Paleness;* and therefore both are found on the coins of that family.

PAW, in the manège. A horse is said to paw the ground, when, his leg being either tired or painful, he does not rest it upon the ground, and fears to hurt himself as he walks.

PAWANGHUR, a fortified town of Hindustan, in the Mahratta territories, province of Bejapoor, and district of Parnella, of which it is the capital. It is considered as a place of great strength, and is forty-two miles south by west from Merritch. Long. 74. 20. E. Lat. 16. 52. N.

PAWN, a pledge or gage for surety or payment of money lent. It is said to be derived *a pugno, quia res quæ pignori dantur, pugno vel manu traduntur;* which is certainly a far-fetched etymology. See Broker.

PAZ, La, the name of a department, a province, and a large city of Bolivia, in South America. A general account of the department, with the number of its inhabitants, will be found in the article Bolivia. The province of La Paz is a district surrounding the city of the same name, in the vicinity of the western cordillera of the Andes, and at a considerable elevation above the level of the sea. This territory is rough and uneven, but fruitful in barley, cocoa, papas, and fruits of various kinds. Its appearance has been described by Mr Temple. "In casting a glance farther round," says he, "you perceive squares and patches of every shade of green and yellow, which, to a European, is perhaps the most striking part of the interesting scene. Corn, and fruit, and vegetables, and crops of every kind, may be seen in all their stages, from the act of sowing to that of gathering them in. Here a field of barley luxuriantly green; there another in full maturity, which the Indians are busily reaping; next to it a crop just appearing above the ground; further on another arrived at half its growth; beyond it a man guiding a pair of oxen, yoked to a shapeless stick, the point of which scratches the earth sufficiently for the reception of the seed, which another man is scattering in the furrows; trees bearing fruit, and at the same time putting forth buds and blossoms, complete the scene of luxuriance. Yet it requires only to raise the eyes from the lap of this fruitful Eden, to behold the widest contrast in the realms of nature. Naked and arid rocks rise in mural precipices around. High above these, mountains, beaten by furious tempests, frown in all the bleakness of sterility; higher still, the tops of others, reposing in the region of eternal snow, glisten uninfluenced in the presence of a tropical sun." The mountains here mentioned are the Nevada de Illimani and others, situated to the south of La Paz. "Illimani, or Yllimani," says Mr Pentland, "appears to derive its name from its icy covering, *Illi*, in the Ymarra dialect of the aborigines, signifying snow. The Nevada of Illimani is situated in latitude 16. 40. Its form is that of a serrated ridge, elongated in the direction of the axis of the chain upon which it rises, offering four principal peaks to the observer, when seen from its western side. From the city of La Paz (latitude 16. 30.), distant about thirty miles, it presents itself with the imposing grandeur of Mont Blanc, when seen from Salanches, or of Monte Rosa, from the subjacent valley of Macugnaga. The elevation of this giant of the Bolivian Cordillera is 24,200 feet, and the lowest glaciers on its northern declivity do not descend below 16,500." This is the highest mountain in the New World, with the exception of the Nevada de Sorata, the highest peak of which attains an elevation of 25,250 feet above the level of the sea.

La Paz, the largest city in the republic of Bolivia, is situated in a deep valley, penetrated by the mountain torrent of Choqueapo. It was founded in the year 1548, and has a fine cathedral, several churches and convents, a college, an hospital, and numerous warehouses for the reception of goods. La Paz is the great emporium of Upper Peru, all merchandize from the coast of the Pacific being transported thither, and then conveyed, by merchants and other dealers, to the towns and villages of the interior. In the seventeenth century, about a league from this city, a large mass of solid gold was found by an Indian, and purchased for about eleven thousand dollars, by the Spanish viceroy, who sent it to the cabinet of natural history at Madrid. Large quantities of native gold have also been found from time to time at the base of the Illimani, in a lake situated at the enormous elevation of 15,780 feet above the level of the sea. This lake is celebrated as having been the depository of a great part of the treasures of the once famed city of Cuzco; for, according to tradition, the Indians chose rather to bury their wealth beneath the waters, than resign it to the rapacity of the invaders. The city of La Paz, although elevated 12,195 feet above the level of the sea, yet, from its sheltered situation, enjoys a mild and pleasant climate. The population amounts to about 40,000.

PEACE, Temple of, a very celebrated fane at Rome, which in the year 191 was consumed by a fire, produced, as some writers suppose, by a slight earthquake. Dio Cassius, however, supposes that the fire began in the adjoining houses; but however this may have been, the temple, with all the surrounding buildings, was reduced to ashes. That magnificent structure had been raised by Vespasian after the destruction of Jerusalem, and enriched with the spoils and ornaments of the temple of the Jews. The ancients speak of it as one of the most stately buildings in Rome. There men of learning used to hold their assemblies, and to deposit their writings, as many others deposited their jewels, and whatever else they esteemed of great value. It was likewise employed as a kind of magazine for the spices which were brought by the Roman merchants from Egypt and Arabia; so that many rich persons were reduced to beggary, all their valuable effects and treasures having been consumed in the conflagration.

PEAK of Derbyshire, a chain of high mountains in the county of Derby, in England, famous for the mines they contain, and also for their remarkable caverns. See Derbyshire.

PEARCE, Dr, lord bishop of Rochester, was the son of a distiller in High Holborn. He received his education in Westminster school, where he was distinguished by his merit, and elected one of the king's scholars. In 1710, when he was twenty years old, he was elected to Trinity College, Cambridge. During the first years of his residence at the university, he occasionally amused himself with lighter compositions, some of which are inserted in the Guardian and Spectator. In 1716, he published his edition of Cicero *De Oratore*, and, at the desire of a friend, dedicated it to Lord Chief Justice Parker, afterwards Earl of Macclesfield, to whom he was an entire stranger. This incident laid the foundation of his future fortune; for Lord Parker soon recommended him to Dr Bentley, master of Trinity, to be made one of the fellows; and the doctor consented to this upon condition that his lordship would promise to "unmake" him again as soon as it lay in his power to give him a living. In 1717, Mr Pearce was ordained at the age of twenty-seven, having taken time enough, as he thought, to attain a sufficient knowledge of the sacred office. In 1718, Lord Parker was appointed chancellor, and invited Mr Pearce to live with him in the capacity of his chaplain. In 1719, the latter was instituted into the rectory of Stapleford Abbots, in Essex; and, in 1720, into that of St Bartholomew, behind the Royal Exchange, worth L.400 a year. In 1723, the lord chancellor presented him to St Martin's-in-the-Fields. His majesty, who was then at Hanover, had been applied to in favour of Dr Claget, who was then along with him, and the doctor actually kissed hands upon the occasion; but, upon the king's return, the chancellor disputed the point, and was permitted to present Mr Pearce. The latter soon attracted the notice and esteem of persons in the highest stations and of the greatest abilities. Besides Lord Parker, he could reckon amongst his patrons or friends, Mr Pulteney, afterwards Earl of Bath, Archbishop Potter, Lord Hardwicke, Sir Isaac Newton, and many other eminent personages. In 1724, the degree of doctor of divinity was conferred on him by Archbishop Wake. The same year he dedicated to his patron the Earl of Macclesfield his edition of Longinus on the Sublime, with a new Latin version and notes.

When the church of St Martin's was rebuilt, Dr Pearce preached a sermon at the consecration, which he afterwards printed, and accompanied with an essay on the origin and progress of temples, traced from the rude stones which were first used for altars to the noble structure of Solomon, which he considers as the first temple completely covered. His observations on the building called the Temple of Dagon removes part of the difficulty which presents itself in the narration of the manner in which Samson destroyed it.

The deanery of Winchester having become vacant, Dr Pearce was appointed to it in 1739; and in the year 1744 he was elected prolocutor of the Lower House of Convocation for the province of Canterbury. His friends now began to think of him for the episcopal dignity; but he appeared rather to decline it. However, after several difficulties had been started and removed, he consented to accept the bishopric of Bangor, and promised Lord Hardwicke to do it with a good grace. He accordingly made proper acknowledgements of the royal goodness, and was consecrated on the 12th of February 1748. Upon the declining state of health of Dr Wilcocks, bishop of Rochester, the bishop of Bangor was several times applied to by Archbishop Herring to accept of Rochester, and the deanery of Westminster, in exchange for Bangor; but he then for the first time signified his desire to obtain leave to resign and retire to a private life. His lordship, however, upon being pressed, suffered himself to be prevailed upon. "My Lord," said he to the Duke of Newcastle, "your grace offers these dignities to me in so generous and friendly a manner, that I promise you to accept them." Upon the death of Bishop Wilcocks he was accordingly promoted to the see of Rochester and deanery of Westminster in 1756. Bishop Sherlock died in 1761, and Lord Bath offered his interest to get the Bishop of Rochester appointed to succeed him in the diocese of London; but the latter told his lordship, that he had determined never to be Bishop of London or Archbishop of Canterbury.

In the year 1763, his lordship being then in the seventy-third year of his age, and finding himself less fit for the business of his stations as bishop and dean, informed his friend Lord Bath of his intention to resign both, and live in a retired manner upon his private fortune. Lord Bath undertook to acquaint his majesty, who named a day and hour, when the bishop was admitted alone into the closet. He told the king, that he wished to have some interval between the fatigues of business and eternity; and desired his majesty to consult proper persons about the propriety and legality of his resignation. In about two months the king informed him that Lord Mansfield saw no objection, and that Lord Northington, who had been doubtful, on further consideration thought that the request might be complied with. Unfortunately for the bishop, Lord Bath had applied for Bishop Newton to succeed him. This alarmed the ministry, who thought that no dignities should be obtained except through their hands. They therefore opposed the resignation; and his majesty was informed that the bishops disliked the design. His majesty sent to him again, and at a third audience told him that he must think no more of resigning. The bishop replied, "Sire, I am all duty and submission;" and then retired. In 1768 he obtained leave to resign the deanery; in 1773 he lost his lady; and after some months of lingering decay he died at Little Ealing, on the 29th of June 1774.

This eminent prelate distinguished himself in every part of his life by the virtues proper to his station. His Literary abilities, and application to sacred and philological learning, appear by his works, the principal of which are, 1. A Letter to the Clergy of the Church of England, on occasion of the Bishop of Rochester's commitment to the Tower, 1722; 2. Miracles of Jesus vindicated, 1727 and 1728; 3. A Review of the Text of Milton, 1733; 4. Two Letters against Dr Middleton, occasioned by the doctor's letter to Waterland, on the publication of his Treatise entitled *Scripture Vindicated*, 1752; and, 5. a Commentary, with notes, on the four Evangelists and the Acts of the Apostles, together with a new translation of St Paul's first Epistle to the Corinthians, and a paraphrase, with notes, in two vols. 4to.

PEARL, in *Natural History*, a hard, white, shining body, usually roundish, found in a testaceous fish, a species of *Mya*. Pearls, though esteemed of the number of gems, and highly valued in all ages, proceed only from a distemper in the animal which produces them, analogous to the bezoars and other stony concretions in several animals of different kinds. Mr Bruce mentions muscles found in the salt springs of the Nubian desert, in many of which he observed those excrescences which might be called pearls, but all of them ill formed, foul, and of a bad colour, though of the same consistence, and lodged in the same part of the body, as those of the sea. "The muscle," says he, "is in every respect similar, I think larger. The outer skin or covering of it is of a vivid green. Upon removing this, which is the epidermis, what next appears is a beautiful pink without gloss, and seemingly of a calcareous nature. Below this, the mother-of-pearl, which is undermost, is a white without lustre, partaking much of the blue and very little of the red; and this is all the difference I observed between it and the pearl-bearing muscle of the Red Sea."

In Scotland, especially to the northward, in all rivers running from lakes, there are found muscles which have pearls of more than ordinary merit, though seldom of large size. They were formerly tolerably cheap, but the wearing of real pearls having come into fashion, those of Scotland have increased in price greatly beyond their value, and superior often to the price of oriental ones when bought in the East. The reason of this is a demand from London, where they are actually employed in work, and sold as oriental. But the excellency of all glass or paste manufactory, it is likely, will keep the price of this article, and the demand for it, within bounds, when every lady has it in her power to wear in her ears, for the price of sixpence, a pearl as beautiful in colour, more elegant in form, lighter and easier to carry, and as much bigger as she pleases, than the famous ones of Cleopatra and Servilla. In Scotland, as well as in the East, the smooth and perfect shell rarely produces a pearl; the crooked and distorted shell seldom wants one.

Artificial PEARLS. There are methods of making artificial pearls, in such manner as to be with difficulty distinguished from the best oriental. The ingredient used for this purpose was long kept a secret; but it is now discovered to be a fine silver-like substance found upon the under side of the scales of the blay or bleak fish. The scales, taken off in the usual manner, are washed and rubbed with fresh parcels of water, and the several liquors suffered to settle; after which the water being poured off, the pearly matter, of the consistence of oil, remains at the bottom, and is called by the French *essence d'orient*. A little of this is dropped into a hollow bead of bluish glass, and shaken about so as to line the internal surface; after which the cavity is filled up with wax, to give solidity and weight. Pearls made in this manner are distinguishable from the natural only by their having fewer blemishes.

*Mother-of-*PEARL, the shell, not of the pearl oyster, but of the *mytilus margaritiferus*.

PEARL-*Ash*, a fixed alkaline salt, prepared chiefly in Germany, Russia, and Poland, by melting the salts out of the ashes of burned wood, and, having reduced them to dryness, evaporating the moisture, and, calcining them for a considerable time in a furnace moderately heated. The goodness of pearl-ashes may be ascertained by a uniform and white appearance; but they are nevertheless subject to a common adulteration, not easily distinguishable by the mere appearance, and which is done by the addition of common salt. Pearl-ashes are much used in the manufacture of glass, and need no preparation, except where very great transparency is required.

PEARSON, JOHN, a learned English bishop, was born at Snoring in 1613. After his education at Eton and Cambridge, he entered into holy orders in 1639, and was the same year collated to the prebend of Netherhaven, in the church of Sarum. In 1640 he was appointed chaplain to the lord-keeper Finch, and by him presented to the living of Torrington in Suffolk. In 1650 he was made minister of St Clement's, East-Cheap, in London. In 1657, he and Mr Gunning had a dispute with two Roman Catholics upon the subject of schism, a very unfair account of which was printed at Paris in 1658. Some time afterwards he published at London an Exposition of the Creed, in folio, dedicated to his parishioners of St Clement's, East-Cheap, to whom the substance of that excellent work had been preached several years before, and by whom he had been desired to make it public. The same year he likewise published the Golden Remains of Mr John Hales of Eton; to which he prefixed a preface, containing a character of that great man, with whom he had been acquainted for many years, drawn up with great elegance and force. Soon after the Restoration, he was presented by Juxon, then bishop of London, to the rectory of St Christopher's in that city; created doctor of divinity at Cambridge, in pursuance of the king's letters mandatory; installed prebendary of Ely, archdeacon of Surrey, and made master of Jesus College in Cambridge, all before the end of the year 1668. On the 25th of March 1661, he was appointed Margaret professor of divinity in that university; and, on the first day of the ensuing year, he was nominated one of the commissioners for the review of the liturgy in the conference held at the Savoy. On the 14th of April 1662, he was admitted master of Trinity College in Cambridge; and, in August, resigned his rectory of St Christopher's and his prebend of Sarum. In 1667 he was admitted a Fellow of the Royal Society. In 1672 he published at Cambridge, Vindiciæ Epistolarum S. Ignatii, in 4to, in answer to M. Daillé; to which is subjoined, Isaaci Vossii Epistolæ Duæ adversus Davidem Blondellum. Upon the death of the celebrated Dr Wilkins, Pearson was appointed his successor in the see of Chester, to which he was consecrated on the 9th of February 1672–1673. In 1682, his Annales Cyprianici, sive tredecim annorum, quibus S. Cyprianus inter Christianos versatus est, Historia Chronologica, was published at Oxford, with Fell's edition of that father's works. Pearson was disabled from all public service by ill health a considerable time before his death, which happened at Chester, on the 16th of July 1686.

PEASANT, a hind, one whose business consists exclusively in rural labour.

PEAT, a well-known inflammable substance, employed in many parts of the world as fuel. There are two species of peat.

The first is a yellowish-brown or black peat, found in moorish grounds in Scotland, Holland, and Germany. When fresh, it is of a viscid consistence, but hardens by exposure to the air. It consists, according to Kirwan, of clay mixed with calcareous earth and pyrites; sometimes also it contains common salt. Whilst soft, it is formed into oblong pieces for fuel, after the pyritaceous and stony matters are separated from it. By distillation it yields water, acid, oil, and volatile alkali, the ashes containing a small proportion of fixed alkali, and being either white or red, according to the proportion of pyrites contained in the substance. The oil which is obtained from peat has a very pungent taste, and an empyreumatic smell, less fetid than that of animal substances, but more so than that of mineral bitumens. It congeals in the cold into a pitchy mass, which liquefies in a small heat; it readily catches fire from a candle, but burns less vehemently than other oils, and immediately goes out upon removing the external flame; and in rectified spirit of wine it dissolves almost totally into a dark brownish-red liquor.

The second species is found near Newbury in Berkshire. In the Philosophical Transactions for the year 1757, we have an account of this species, the substance of which is as follows: Peat is a composition of the branches, twigs, leaves, and roots of trees, with grass, straw, plants, and weeds, which, having lain long in water, is formed into a mass soft enough to be cut through with a sharp spade. The colour is a blackish brown, and it is used in many places for fuel. There is a stratum of this peat on each side of the Kennet, near Newbury in Berks, which is from about a quarter to half a mile in width, and many miles in length. The depth below the surface of the ground is from one foot to eight. Great numbers of entire trees are found lying irregularly in the true peat. These are chiefly oaks, alders, willows, and firs, and appear to have been torn up by the roots; many horses' heads, and bones of several kinds of deer, the horns of the antelope, the heads and tusks of boars, and the heads of beavers, are also found embedded in it.

PEBAS, a district of Peru, in South America, situated upon the left bank of the river Marañon, to the east of the confluence of the Ucayale with that river. It produces cocoa, sarsaparilla, vanilla, white and black bees-wax, maize, yucas, plantains, camotas, and papayas, and some dye-stuffs of a peculiar description. The river here supplies vaca marina, tartaruga, gavitanas, sungarros, and pacos. In the woods there are tigers, tapirs, deer, roonsookas, and black and white monkeys. The pueblo or town of Pebas is situated on a height, upon an elevated part of the bank of the river. It is built without any regard to regularity, and is chiefly inhabited by Indians, who are a cheerful and industrious race of people.

PEBBLES, a trivial name frequently given to different varieties of the agate and calcedony.

PECK, Francis, a laborious and learned antiquary, was born at Stamford, in Lincolnshire, on the 4th of May 1692, and educated at Cambridge, where he took the degrees of bachelor and master of arts. He was the author of many works, the first of which is a poem entitled Sighs on the Death of Queen Anne, printed probably about the time of her death in 1714. Two years afterwards he printed an Exercise on the Creation, and a Hymn to the Creator of the World, being an attempt to show the beauty and sublimity of the Holy Scriptures, 1716, 8vo. In 1721, being then curate of King's Clifton in Northamptonshire, he issued proposals for printing the History and Antiquities of his native town, a work which was published in 1727, in folio, under the title of Academia tertia Anglicana, or the Antiquarian Annals of Stamford, in Lincoln, Rutland, and Northamptonshires, inscribed to John duke of Rutland. This work was hastened by an Essay on the Ancient and Present State of Stamford, 1726, in 4to, written by Francis Hargrave, who, in his preface, mentions the difference which had arisen between him and Mr Peck, on account of his publication having forestalled that intended by the latter. Mr Peck is also very roughly treated on account of a small work which he had formerly printed, entitled the History of the Stamford Bull-running. Mr Peck had before this time obtained the rectory of Godeby, near Melton, in Leicestershire, the only preferment he ever enjoyed. In 1729, he printed, on a single sheet, Queries concerning the Natural History and Antiquities of Leicestershire and Rutland, which were afterwards reprinted in 1740; but although the progress he had made in the work was considerable, yet it never made its appearance. In 1732 he published the first volume of Desiderata Curiosa, or a Collection of various scarce and curious Pieces relating chiefly to Matters of English History. This volume was dedicated to Lord William Manners, and was followed, in 1735, by a second volume, dedicated to Dr Reynolds, bishop of Lincoln. In the year 1735 Mr Peck printed a complete catalogue of all the discourses written for and against Popery in the time of King James II., containing in the whole an account of 457 books and pamphlets, a great number of them not mentioned in the three former catalogues; with references after each title, for the more speedily finding a further account of the said discourses and their authors in sundry writers, and an alphabetical list of the writers on each side. In 1739 he edited Nineteen Letters of the Reverend Dr Henry Hammond, author of the Annotations on the New Testament, written to Mr Peter Stainnough and Dr Nathaniel Angelo, many of them on curious subjects. These were printed from the originals, communicated by Mr Robert Marsden, archdeacon of Nottingham, and Mr John Worthington. The next year, 1740, he produced two volumes in quarto, one of them entitled Memoirs of the Life and Actions of Oliver Cromwell, as delivered in three panegyrics of Noll, written in Latin, and supposed to have been composed by John Milton, Latin secretary to Cromwell. The other contained New Memoirs of the Life and Poetical Works of Mr John Milton, with an examination of Milton's style, and explanatory and critical notes on different passages in Milton and Shakspeare, by the editor; besides a variety of other pieces, which it would be tedious to enumerate. These were the last publications which he gave the world. When they appeared, however, he had in contemplation no less than nine different works; but, from some cause not explained, none of them was ever made public. He concluded a laborious, and, it may be added, useful life, wholly devoted to antiquarian pursuits, on the 13th of August 1643, at the age of sixty-one years.

PECS, a city of the Austrian kingdom of Hungary, in the province of the Hither Danube, and circle of Baranyer. It is situated on a river of the same name, upon whose banks it extends in a single street more than six miles in length. It is the see of a bishop, the seat of a Catholic seminary, and contains convents and hospitals, with 2160 houses, and 9640 inhabitants, who produce vinegar, tobacco, starch, and some good wine. It has also much trade, arising from several great fairs for cattle and leather, which are held there. Long. 18. 10. E. Lat. 46. 5. 13. N.

PECTORAL, a sacerdotal habit or vestment, which was worn by the Jewish high priest. The Jews call it *Hhoschen*, the Greeks γολιον, the Latins *rationale* and *pectorale*, and in our version of the Bible it is called *breastplate*. It consisted of embroidered stuff, about a span square, and was worn upon the breast, set with twelve precious stones, arranged in four rows, and containing the names of the twelve tribes. It was fastened to the shoulder by two chains and hooks of gold. God himself prescribed the form of the pectoral.

Pectoral, a breastplate of thin brass, about twelve fingers square, worn by the poorer soldiers in the Roman army, who were rated under one thousand drachmæ.

PECULIAR, in the *Canon Law*, signifies a particular parish or church that has jurisdiction within itself for granting probates of wills and administrations, exempt from the ordinary or bishop's courts. The king's chapel is a royal peculiar, exempt from all spiritual jurisdiction, and reserved to the visitation and immediate government of the king himself. There is likewise the archbishop's peculiar; for it is an ancient privilege of the see of Canterbury, that wherever any manors or advowsons belong to it, these forthwith become exempt from the ordinary, and are reputed peculiars. In the see of Canterbury there are fifty-seven such peculiars.

Besides these, there are some peculiars belonging to deans, chapters, and prebendaries, which are only exempted from the jurisdiction of the archdeacon. They are derived from the bishop, who may visit them, and to whom there lies an appeal.

Court of Peculiars is a branch of, and annexed to, the court of arches. It has a jurisdiction over all those parishes dispersed throughout the province of Canterbury in the midst of other dioceses, which are exempted from the ordinary's jurisdiction, and subject only to the metropolitan.

PECULIUM signifies the stock or estate which a person in the power of another, whether male or female, either as his or her slave, may acquire by his industry. Roman slaves frequently amassed considerable sums in this way. The word properly signifies the advanced price which a slave could get for his master's cattle or stock above the price fixed upon them by his master, and which was the slave's own property.

In the Catholic church, *peculium* denotes the goods which each religious reserves to and possesses by himself.

PEDAGOGUE, or PÆDAGOGUE, a tutor or master, to whom is committed the discipline and direction of a scholar, to be instructed in grammar and other arts. The word is formed from the Greek παιδων ἀγωγος, *puerorum ductor*, or leader of boys.

PEDAL (*pedale* in Italian), is a musical term of various meanings. For example, *pedal* means one of the largest pipes, or one of the foot-keys, of an organ; or the foot-piece attached to a piano-forte, a harp, or the like, and by which, in the former, the intensity of the sound is modified, and, in the latter, the chromatic changes of intonation are produced. It also signifies a particular sort of passage in the course of a piece of music, where the harmony moves upon a sustained sound, which is either the dominant or the tonic of the key. (See the article MUSIC, vol. xv. p. 640.)

PEDANT, a schoolmaster or pedagogue, who professes to instruct and govern youth, and to teach them the languages and the arts.

PEDANT is also used for a rough, unpolished man of letters, who makes an impertinent use of the sciences, and abounds in unseasonable criticisms and observations.

PEDARIAN, in Roman antiquity, were those senators who signified their votes by their feet, not with their tongues; that is, such as walked over to the side of those whose opinion they approved of, in divisions of the senate. Dr Middleton thus accounts for the origin of the word. He says, that though the magistrates of Rome had a right to a place and vote in the senate both during their office and after it, and before they were put upon the roll by the censors, yet they had not probably a right to speak or debate there upon any question, at least in the earlier ages of the republic. For this seems to have been the original distinction between them and the ancient senators, as is plainly intimated in the formula of the consular edict, sent abroad to summon the senate, which was addressed to all senators, and to all those who had a right to vote in the senate. From this distinction, those who had only a right to vote were called in derision *pedarian;* because they signified their votes by their feet, not their tongues, and upon every division of the senate went over to the side of those whose opinion they approved. It was in allusion to this ancient custom, which seems to have been wholly dropped in the latter ages of the republic, that the mute part of the senate continued still to be called by the name of *pedarians;* as Cicero informs us, who, in giving an account to Atticus of a certain debate and decree of the senate upon it, says that it was made with the eager and general concurrence of the pedarians, although against the authority of all the consulars.

PEDATURA, a term used in Roman antiquities to indicate a space or proportion of a certain number of feet set apart. This word often occurs in writers on military affairs. In Hyginus *De Castrametatione* we meet with the following passage, viz. "Meminerimus itaque ad computationem cohortis equitatæ milliariæ pedaturam ad mille trecentos sexaginta dari debere;" the meaning of which is, that *pedatura*, or space allowed for a *cohors equitata* or provincial cohort, consisting of both horse and foot, could not be the same as the *pedatura* of an uniform body of infantry, of the same number, but must exceed it by 360 feet; for the proportion of the room occupied by one horseman to that occupied by one foot soldier was estimated as two and a half to one.

PEDDABALABARAM, a town of Hindustan, in the Mysore rajah's territories. The fort is built entirely of mud, but it is nevertheless large and strong; and one side is surrounded by gardens, the other by the town. Its trade is inconsiderable. Long. 77. 47. E. Lat. 13. 17. N.

PEDDAPORE, a town of Hindustan, in the Northern Circars, and district of Rajamundry, twenty-five miles east-north-east from the town of Rajamundry. Sugar is cultivated in the neighbourhood to a considerable extent. A battle was fought here in 1758, between the French and English, in which the former were totally defeated. Long. 82. 15. E. Lat. 17. 5. N.

PEDESTAL, in *Architecture*, the lowest part of an order of columns, being that part which sustains the column, and serves it as its base.

PEDIÆAN, in Grecian antiquity. The city of Athens was anciently divided into three different parts; one on the descent of a hill, another on the sea-shore, and a third in a plain between the other two. The inhabitants of the middle region were called Πεδιαιοι, *Pediæans*, from πεδιον, plain or flat; those of the hill, Diacrians; and those of the shore, Paralians. These quarters usually composed as many different factions. Pisistratus made use of the Pediæans against the Diacrians. In the time of Solon, when a form of government was to be chosen, the Diacrians chose the democratic, the Pediæans demanded an aristocracy, and the Paralians a mixed government.

PEDICLE, amongst botanists, that part of a stalk which immediately sustains the leaf of a flower or a fruit, and is commonly called a *footstalk*.

PEDIR, a town on the western coast of the island of Sumatra, from which are exported betel-nut, pepper, gold dust, canes, rattans, bees-wax, camphor, and benzoin or frankincense. The soil around is fertile, and the country well watered.

PEDOMETER, or PODOMETER, formed from πους, *pes*, foot, and μετρον, measure, a mechanical instrument, in the form of a watch, consisting of various wheels with teeth, catching in one another, all disposed in the same plane, which, by means of a chain or string fastened to a man's foot, or to the wheel of a chariot, advance a notch each step, or each revolution of the wheel; so that the number being marked on the edge of each wheel, one may number the paces, or measure exactly the distance from one place to another. There are some of them which mark the time on a dial-plate, and, being very much like a watch, are accordingly worn in the pocket.

PEDRA BLANCA, a large and elevated rock, perfectly white, and situated in the Sea of China. Long. 114. 57. E. Lat. 22. 19. N.

PEDRO, DOM, of Portugal, Duke of Coimbra, was the fourth child and second surviving son of King John of Portugal, and was born on the 4th of March 1394. His father gave him an excellent education, which, joined to strong natural abilities and much application, rendered him one of the most accomplished princes of his time. He was not only very learned himself, but a great lover of learning, and also a patron of learned men. It was chiefly with a view to improve his knowledge that he spent four years in travelling throughout different countries in Europe, Asia, and Africa, with a train suitable to his quality. There is a relation of these travels still extant, but so loaded with fabulous circumstances, that it wounds the reputation it was designed to raise. At his return he espoused Isabella, daughter to the Count of Urgel, and grand-daughter to Dom Pedro, the fourth king of Portugal; which was esteemed a very great advancement of his fortune. He was elected a member of the most noble order of the Garter on the 22d of April 1417, in the fifth year of the reign of his cousin Henry V. a grandson of John of Gaunt by the father's side, as our Duke of Coimbra was by the mother. In 1440 he was declared regent during the minority of his cousin Dom Alonzo V. son of King Edward, who died of the plague. He found some difficulty at first in the discharge of his office, both from the queen-mother and others. But, upon the whole, his administration was so mild and so just, that the magistrates and the people of Lisbon concurred in demanding permission to erect a statue to him. The regent thanked them, said he should be unwilling to see a work of theirs demolished, and that he was sufficiently rewarded by this public testimony of their affections. The queen dowager wished to raise disturbances in Portugal, by aiming at recovering the regency to herself; but the steadiness of the regent's administration, the attachment of the greater part of the nobility to him, and his enjoying in so absolute a degree the confidence of the people, not only secured the interior tranquillity of the state, but likewise raised the credit of the crown of Portugal to a very great height in the estimation of its neighbours. In the course of his regency he had made it his continual study to pursue the public good; to ease the people in general, and the inhabitants of Lisbon in particular, of several impositions; to maintain the laws in their full vigour; to give the king an excellent education; and, if that had been at all practicable, to diffuse a perfect unanimity throughout the court, by assuaging the malice and envy of his enemies. The king, when he came of age, and the *cortes* or parliament, expressed their entire satisfaction with the regent's administration; and all parties entirely approved of the king's marriage with Donna Isabella, the regent's daughter, which was celebrated in 1446. The enmity of his enemies, however, was not in the least abated by the regent's being out of office. They still persecuted him with their unjust calumnies, and unfortunately induced the king to hearken to their falsehoods. The unfortunate duke, when ordered to appear before the king, was advised to take with him an escort of horse and foot. In his passage he was proclaimed a rebel, and almost immediately surrounded by the king's troops. Soon afterwards he was attacked, and killed in the heat of action. Nor was the envy of his enemies even then satiated. His body was denied burial, and at length taken away privately by the peasants. But his virtue, however hated in courts, was adored by the uncorrupt part of his countrymen. At length, by an inspection of his papers, the king saw, when it was too late, the injustice which had been done to the man who had behaved so well in a high and difficult office; and his papers discovered indications of further benefit contemplated for the king and his dominions. In consequence of these discoveries, the duke's adherents were declared loyal subjects, all prosecutions were ordered to cease, and the king desired the body of Coimbra to be transported with great pomp from the castle of Abrantes to the monastery of Batalha, where it was interred in the tomb which he had caused to be erected there for himself.

PEEBLESSHIRE, or TWEEDDALE, a county in Scotland, situated between 55. 24. and 55. 50. north latitude, and between 2. 45. and 3. 23. west longitude from Greenwich. It is bounded on the north by Mid-Lothian or Edinburghshire, on the east by the county of Selkirk, on the south by Dumfriesshire, and on the west by Lanarkshire. Its greatest extent from north to south is about thirty miles, and its greatest breadth from east to west about twenty-two; the contents being 229,778 English acres, of which only about a tenth part is fit for cultivation. It is divided into sixteen parishes, twelve of which form the presbytery of Peebles, and four belong to that of Biggar, but all are under the synod of Lothian and Tweeddale.

The surface of this county is hilly, and towards the south mountainous, several of the high grounds in that quarter, such as Hartfield, Harstane, Broadlaw, and Dollarlaw, being from 2800 to nearly 3000 feet above the level of the sea. The general elevation of the pasture lands is about 1200 feet; yet, with few exceptions, the hills are covered with green herbage, heath being almost confined to a few of the highest ridges on the south-east. On the banks of its streams are many pleasant and fertile spots; but, from the want of wood, the general appearance is naked and uninteresting; though of late great attention has been paid to planting, and it is estimated that there are now nearly 7000 acres under wood. The soil of the cultivated land, lying chiefly on the sides of the lower hills and the banks of the streams, is for the most part a light loam, with clay, moss, and moor on the high grounds. Coal, limestone, and freestone abound in the parishes of Linton and Newlands, on the north side of the county, and in the latter ironstone is also found. Limestone and freestone are worked profitably in the parish of Linton; but the coal formerly obtained from Newlands has been abandoned, as not repaying the cost of outlay. Lime, however, may still be purchased at Magbiehill, the coal for burning which is brought from Linton. At Stobo, slate of a good quality is quarried, and sold with advantage to the proprietor. In the parish of Traquair there is also a slate quarry in active operation. The river Tweed, from which this district is often called Tweeddale, rises from a well of the same name, in the parish of Tweedsmuir, in the south-western extremity of the county, about 1500 feet above the level of the sea, and, flowing first north-east and then east, dividing the county into two nearly equal parts, it passes into Selkirkshire at Gatehaup Burn, after a winding course of about thirty-six miles. The Annan and the Clyde have their source in the same hill. Of the other streams, here called *waters*, the most considerable are Biggar, Lyne, Peebles or Eddlestone, Leithan, Mannor, and Quair, which fall into the Tweed; and the North and South Esks, which pursue their course into Mid-Lothian. The lakes or lochs are St Mary's, Waterloch, and Slipperfield. These, as well as the rivulets, abound in the common fresh-water fish, and most of the streams are occasionally frequented by salmon; but salmon are not found in such numbers, even in the Tweed, within the bounds of this county, as to afford a fishery that will pay rent.

The climate of Peeblesshire, owing to its elevation and want of shelter, is perhaps more rigorous than that of any other of the southern counties of Scotland. Cold easterly winds prevail in spring, and greatly retard vegetation; whilst in summer frosts often occur, which injure the potato and other crops; and the winters are frequently so severe as to destroy turnips, the snow lying so deep and so long as sometimes to occasion great loss amongst the flocks.

As this is almost exclusively a pastoral country, the farms are in general large, most of them being from 1000 to 4000 acres. On the arable land they are small, the greater number being below 100 acres. These are in general held on leases for nineteen years, as in other parts of Scotland. Taking the extent and rental as before stated, the average would be nearly five shillings the English acre. This is chiefly derived from live stock, especially sheep, of which there may be about 120,000. These were formerly of the black-faced heath variety, sometimes called Tweeddale sheep, from the name of the county, or Linton sheep, from the name of a village on the northern side of the district, where great fairs are held for the sale of them; but of late years the Cheviot breed, which bears a much more valuable fleece, has been established on many of the lower hills, and the majority of those now fed in the county are of this variety. The crops are the same as in other parts of Scotland, excepting that wheat is cultivated only upon a very small scale. A variety of oats called the *red oat*, and sometimes the *Mag-*

biehill oat, from its being first cultivated here on that estate, is very well adapted to high and exposed situations, both because it ripens earlier than the common kind, and is less liable to be beaten out by wind, whilst on good land it is found to be highly productive.

Many of the proprietors have seats distinguished either for their antiquity or their beauty; but the Earl of Traquair is the only nobleman who now resides in the county. Peeblesshire, in 1811, was divided into about eighty estates, many of them large, but not valuable in proportion. The valuation of the whole is L.51,937. 13s. 10d. Scotch; and the real rent, as assessed for the property-tax that year, was, for the lands L.57,382 sterling, and for the houses L.2568. Two thirds of the estates are valued under L.500 Scotch, a sum which may indicate pretty nearly their present yearly value in sterling money; and little less than two thirds of the whole are entailed.

In the county there are several remains of Roman camps. Drochil Castle in the parish of Newlands, and Nedpath Castle in the parish of Peebles, are the only two which are in tolerable preservation; but vestiges of ancient castles or towers abound in the whole valley of the Tweed. The remains of the Castle of Tinnes or Thanes are six feet in thickness, and the mortar is as hard as the stone.

The inhabitants are generally educated, intelligent, and attentive to religious duties, though few of the labouring classes or shepherds consider poaching as in any degree criminal, and accordingly practise it to a considerable extent, both by land and water. To this they are tempted by the abundance of the game, which in some districts is most destructive to the poor. The principal towns or villages in Peeblesshire are, Peebles, Linton, Eddlestone, Skirling, Broughton, and Innerleithen. At this latter place, Lord Traquair, the proprietor of the village, has erected a neat building with corridor over a mineral well, which for some years past has attracted numerous visitors to the village during the summer.

The royal burgh of Peebles formerly joined with Selkirk, Lanark, and Linlithgow, in returning a member for the burghs; but since the passing of the reform act, the burgh is merged in the county, and both united return a member to serve in parliament; the qualification to vote for a candidate being the same in the burgh as in the county, viz. ten pounds property, or fifty pounds rental per annum. At the passing of the reform act there were, of old constituency forty-seven, new constituency 300; but, in consequence of the creation of votes for party purposes, there are now 760 electors on the poll-books.

Population in 1831.

Parish or Burgh.	HOUSES.				OCCUPATIONS.			PERSONS.		
	Inhabited.	Families.	Building.	Uninhabited.	Families chiefly employed in Agriculture.	Families chiefly employed in Trade, Manufactures, and Handicraft.	All other Families not comprised in the two preceding classes.	Males.	Females.	Total of Persons.
Broughton	49	51	...	...	13	15	23	154	145	299
Drumelzier	42	42	...	2	26	8	8	107	116	223
Eddlestone	144	144	3	...	80	29	35	439	397	836
Glenholm	48	50	...	...	30	7	13	127	132	259
Innerleithen (part of)	138	150	1	2	51	33	66	357	389	746
Kilbucho	59	59	1	2	31	11	17	163	190	353
Kirkurd	58	58	...	1	31	10	17	161	157	318
Linton, West	269	297	3	8	63	92	142	867	710	1577
Lyne and Thiggate	25	26	1	...	20	2	4	83	73	156
Manor	35	41	...	2	34	6	1	129	125	254
Newlands	186	205	...	11	109	38	58	523	555	1078
Peebles (part of burgh and parish)	455	643	4	15	93	365	185	1366	1384	2750
Skirling	61	64	...	1	22	17	25	172	186	358
Stobbo	66	85	...	3	41	8	36	213	227	440
Traquair	105	108	1	8	68	20	20	336	307	643
Tweedsmuir	49	49	...	3	24	5	20	145	143	288
	1789	2072	14	58	736	666	670	5342	5236	10578

PEEBLES, the county-town, is not distinguished for any particular trade or manufacture. The majority of the operatives are hand-loom weavers, whose wages do not average more than from five to seven shillings per week; the remainder of their living being procured by fishing, harvest-work, &c. It is not known when Peebles was erected into a royal burgh; but in 1357 the burgh sent two members to parliament. The property of the burgh, consisting of lands, mills, &c. yields an annual revenue of L.1343. 11s. 2d., which is expended in salaries to teachers, in paving and lighting the streets, supplying the town with water, and other useful purposes. The whole matters of police are regulated by a provost, two bailies, a treasurer, dean of guild, and twelve councillors, chosen by the inhabitants. Considerably more property was secured to the burgesses and inhabitants by charter of James VI. dated the 10th of November 1621; but, as in most of the other burghs, this was dissipated by the members of the corporation. Peebles is divided into the old and the new town; and it is bounded on the south by the Tweed, and on the north by the Eddlestone Water. It is worthy of remark, that the Tweed runs almost from due west to east, whilst the Eddlestone Water, on the other side of the town, flows exactly in the contrary direction. The population returns for the burgh and parish were, in 1811, 2485; in 1821, 2701; and in 1831, 2750. The real value is estimated at L.9255. Peebles is distant twenty-two miles south of Edinburgh.

PEEK, in nautical language, is a word used in various senses. Thus the anchor is said to be a-peek when the ship, being about to weigh, comes over her anchor in such a manner that the cable hangs perpendicularly between the hawse and the anchor.

To heave a-peek is to bring the peek so that the anchor may hang a-peek. A ship is said to ride a-peek when, lying with her main and fore-yards hoisted up, one end of her yards is brought down to the shrouds, and the other raised up on end; which is chiefly done when she lies in rivers, lest other ships, falling foul of the yards, should break them. Riding a broad peek denotes much the same thing, excepting that the yards are only raised to half the height.

Peek is also used for a room in the hold, extending from the bitts forward to the stern. In this room men of war keep their powder, and merchantmen their provisions.

PEEL, a town on the western side of the Isle of Man, in the Irish Channel, formerly called Holm. It is a scattered place, containing nothing remarkable excepting an old cathedral in a dilapidated state, and a castle on a small island, or rather rock, at the mouth of the river of the same name as the town. It has but little trade, and about 1300 inhabitants.

PEELAS Isles, a cluster of small islands in the Eastern Seas. Plenty of cowries are found along the beach. The Peelas are covered with wood, but are destitute of fresh water, and have no settled population.

PEER, in general, signifies an equal, or one of the same rank and station. Hence, in the acts of some councils, we find these words: " with the consent of our peers, bishops, abbots," and others. Afterwards the same term was applied to the vassals or tenants of the same lord, who were called peers, because they were all equal in condition, and obliged to serve and attend him in his courts; and peers *in fiefs*, because they all held fiefs of the same lord.

Peer *of the Realm*, a lord who has a seat and vote in the House of Lords, which is also called the House of Peers. These lords are called peers, because, though there is a distinction of degrees in our nobility, yet in public actions they are equal; as in their votes in parliament, and in trying any nobleman or other person impeached by the Commons. See Parliament.

PEERESS, a woman who is noble by descent, by creation, or by marriage. As we have noblemen of several ranks, so we may also have noblewomen. Thus Henry VIII. made Anne Boleyn, Marchioness of Pembroke; James I. created the Lady Compton, wife of Sir Thomas Compton, Countess of Buckingham, in the lifetime of her husband, without any addition of honour to him; the same king also made the Lady Finch Viscountess of Maidstone, and afterwards Countess of Winchilsea, to her and the heirs of her body; and George I. made Lady Schulenberg Duchess of Kendal. If a peeress, by descent or creation, marry a person under the degree of nobility, she still continues noble; but if she obtain that dignity only by marriage, she loses it on her afterwards marrying a commoner; yet, by the courtesy of England, she generally retains the title of her nobility.

PEERGAUM, a town of Hindustan, in the Mahratta territories, and in the province of Aurungabad, sixty-eight miles east from Poonah. Long. 75. 2. E. Lat. 18. 32. N.

PEGASUS, amongst the poets, a horse imagined to have had wings, being that on which Bellerophon was fabled to have mounted when he engaged the Chimæra.

Pegasus, in *Astronomy*, the name of a constellation of the northern hemisphere, in the form of a flying horse.

PEGAU, a city of the kingdom of Saxony, situated in the circle of Leipsich, and bailiwick of Borna. It is built on the banks of the White Elster, and contains two churches, 420 houses, and 2680 inhabitants, employed in making various kinds of linen goods, and also as shoemakers.

PEGMARES, a name by which certain gladiators were distinguished, who fought upon moveable scaffolds called *pegmata*, which were sometimes unexpectedly raised, and by this means surprised the people with gladiators in hot contention. These scaffolds were sometimes lifted up so suddenly as to throw the combatants into the air; and sometimes they were let down into dark and deep holes, and then set on fire, thus becoming the funeral piles of those miserable wretches, and roasting them alive to divert the brutal populace.

PEGU, formerly an independent kingdom of Asia, now incorporated with the Birman empire, by whose sovereign it was subdued, after long wars. The limits of this state were never very accurately defined, and it probably varied with the fate of war. It included a large tract of country, about 350 miles in length from north to south, and as much in breadth from east to west, situated on and comprising a large portion of the delta of the Irrawaddy. Arracan and Ava were its northern boundaries, Siam its limit on the east, on the south Siam and the sea, and on the west the Bay of Bengal and part of Arracan.

This country, being intersected by the Irrawaddy and its branches, is fertile and well watered; but, owing to the desolations of war, it is wild and uncultivated, overrun in many places with jungle or rank luxuriant grass, affording cover for wild animals, such as tigers, elephants, buffaloes, deer, and other animals. Both banks of the river are covered everywhere with a narrow belt of tall reedy grass. The country from Rangoon throughout is a low champaign. As far as the tide reaches it is covered with a narrow belt of tall reedy grass, and behind with a thick and continuous forest of moderate-sized trees, amongst which the most frequent and remarkable are the *sonneratia appetalu*, and *heritiera fomes*. Here and there are a few grassy plains. The character of the vegetation changes where the influence of the tide ceases. The country is then covered with a tall rushy grass, a species of saccharim, amongst which are scattered trees of from twenty to sixty feet in height. There is very little appearance of inhabitants along the shores of the river, which ought to be the most populous portion of the country. Here and there, on the immediate banks, are a few fishing villages, and in the interior other agricultural villages, with a few patches of rice culture about them. The only culture of any extent is that of the banana, of which extensive groves line the sides of the river. In some parts advantage is taken of the vicinity of the river for the purposes of irrigation; but in general the country is nearly in a desolate state. Symes, who was sent as ambassador to Ava, gives a similar description of the country. " The country round," he observes, " as far as our view could reach, displayed a level plain, with clumps of trees at distant intervals; a thick reedy grass had grown in some places very high; in others, where it had been burnt, there appeared good pasturage for cattle; we saw the embanked divisions of a few rice plantations, and discovered the vestiges of former culture and population; but during a walk of two hours the eye was not gratified with the sight of house or inhabitant. Desolated by the contentions of the Birmans and Peguans, the country had not yet recovered from the ravages of war. In our walk we observed many tracks of wild elephants, the spots where hogs had rooted and deer lain, and found the remains of two antelopes that had recently been killed, and were half devoured by tigers. The walks on each side of the river are low, and the land seems adapted to produce excellent crops; but it is now quite deserted, and become the undisputed domains of the wild beasts of the forest." The chief produce of the country is rice; but where those who sow are not sure that they shall reap the fruits, they seldom cultivate more than suffices for their immediate subsistence; and to such grievous oppression have the people often been subjected, that they have been forced to abandon their villages and fly into the woods, where they have cultivated small patches of ground, and lived principally upon fish, fowl, venison, and reptiles. The country around Pegu, the capital, was completely laid waste by the victorious troops of Alompra, when he conquered that city in 1757; and to such oppressions were the Peguans subjected, that the country, though fruitful in the extreme, and one of the fairest and most healthful on the globe, has never recovered its former prosperity. The subjugation of the people by the Birmans ushered in a long era of tyranny and persecution, under which, though mitigated, they still suffer. Severe penal laws were imposed on the Taliens or native Peguans. But these have been abrogated by the present sovereign; justice has also been more impartially administered; and it is mentioned by Symes, that the only distinction between the subjected Peguans and the Burmese is the exclusion of the former from all places of public trust and power. The people have also been more reconciled to the Birman yoke by other proceedings of the present monarch, especially by the order which he issued for rebuilding Pegu the capital, encouraging settlers by grants of ground, and inviting the scattered families of former inhabitants to return and re-people their deserted city. The preservation and embellishment of the ancient national temple of Shoomandoo, which has been ordered by the government, is also a popular act. These measures do not appear, however, to have conciliated the Peguans, as Mr Crawford, who visited the country, mentions that in 1827 they had risen in rebellion against the authority of the Burmese; and he was himself a witness to an action between the two contending parties.

Pegu possesses mines of iron, tin, and lead; also of precious metals, namely, rubies, sapphires, and rock crystal. Its most valuable produce, however, is the teak timber, used for ship-building, which is impervious to worms or the bad effects of salt water. The trees, some of which are sixty feet in length by nine in girth, are floated down the Irrawaddy and its tributaries during the rainy seasons. This river is the largest in the country, and, about a hundred miles from the sea, divides into numerous branches, the principal being those of Persaim and Rangoon, which overflow an extensive tract during the rainy season. The Sitang, another large river, flows into the Gulf of Martaban. The principal ports are Siriam, Negrais, and Rangoon.

The history of the eastern nations is for the most part involved in darkness, until the period when the Europeans, in the progress of navigation, found out a maritime route to India; and we learn from the testimony of the Portuguese historians, that about this time four powerful states divided amongst them the regions which lie between the south-east province of British India, Yunan in China, and the Eastern Sea. These states were distinguished amongst the Europeans by the names of Arracan, Ava, Pegu, and Siam; and, from all that is known respecting them, it appears that they carried on constant wars with each other, and with various success. It is mentioned on the authority of Mendez Pinto, that the Birmans, though formerly subject to the king of Pegu, became afterwards masters of Ava, and caused a revolution in Pegu about the middle of the sixteenth century. Their supremacy continued throughout the seventeenth and also during the first forty years of the last century, when the Peguans in the provinces of Dalla, Martaban, Tongo, and Prome revolted, and a civil war ensued, which was carried on by both parties with the most revolting ferocity. In the year 1744 the British factory at Siriam was destroyed by the rage of the contending parties. After a tedious and protracted war, which was long doubtful, the Peguans, aided with arms by European traders, and joined by renegade Dutch and Portuguese adventurers, gained important advantages over the Birmans, in the years 1750 and 1751. They finally invested Ava, the capital, which the Birmans, disheartened by defeat, surrendered at discretion, and Dweepdee, the last of a long line of kings, was made prisoner with all his family, excepting two sons, who fled to the Siamese, from whom they met with a friendly reception, and with assurances of succour. Apporaza, the brother of the king of Pegu, was left in Ava, the capital, to complete the reduction of the Burmese. But a deliverer unexpectedly arose to the Birmans, in the person of the celebrated Alompra, who was of low extraction, but endowed with a spirit of boldness and enterprise which qualified him for great achievements. He had collected around him a hundred devoted followers, on whom he could rely; and, availing himself of the favourable opportunity when the Birmans were exasperated by oppression, and when the garrison of Ava had been greatly diminished, he attacked the Peguans with irresistible fury, and put every man to the sword. He then retreated to the fort of Monchaboo, where he repelled the feeble assaults of the Peguans, and became the assailant in his turn, attacking and defeating their scattered forces, and finally advancing, by a bold and well-concerted movement, to Ava, of which he took possession. A large armament was now fitted out by the king of Pegu, the command of which was given to Apporaza, who, ascending the stream of the Irrawaddy, appeared before Ava, which he summoned to surrender, but which Shemhuan, the lieutenant of Alompra, declared that he would defend to the last extremity. Alompra had in the mean time collected a formidable fleet, which Apporaza proceeded to attack. The action, which was obstinate and bloody, terminated in the entire discomfiture of the Peguan general, who retired with the wreck of his army to his own country. This action took place in 1754. An alarm was at this time spread in Pegu, that the Birmans in that city were engaged in a conspiracy against the government, upon which the terrified inhabitants flew to arms, and having murdered the deposed monarch, who was detained in prison, they proceeded to put to death every Birman who was found within the city. This act of cruelty was the signal for a general revolt of the Birmans throughout the empire, who retaliated the barbarity of their oppressors, and quickly made themselves masters of Prome, Denobew, Loonzay, and other places. The monarch of Pegu, Beinga Della, alarmed by this disastrous intelligence, levied a new army, with which he marched from Pegu, and commenced the siege of Prome. The city made a resolute defence; and the besiegers, repelled in several attacks, were forced to convert the siege into a blockade. Alompra detached part of his fleet and army to the aid of the besieged, and forty days afterwards followed with his choicest troops. He immediately commenced an attack on the works of the besiegers, who, defeated in a long, close, and bloody action, were at length compelled to seek safety in a precipitate flight. Alompra did not fail to improve his victory. He commenced an active pursuit, and his troops advanced within a few leagues of Bassein unmolested by the enemy. The intelligence of this disaster spread consternation throughout the dominions of Pegu; the king retired from Bassein to his capital; his adherents, abandoned and terrified, consulted each his own safety, and the town and fort of Persaim were completely deserted. Each party was at this time anxious to procure the aid of the French or English, who had factories at Syriam, and who alternately espoused the one or the other side, according as it seemed to suit their interests. Many skirmishes ensued, and the war was for some time carried on without any decisive success on either side. The Birmans, however, supported by the vigour and capacity of Alompra, were making slow but sure advances, and in April 1755 that chief gained a decided victory over Apporaza, in his camp at Synangong. The Peguans, disheartened, fled to Syriam, and many did not halt till they reached Pegu itself. The Birmans soon afterwards took possession of Rangoon; and an attempt to recover the place by the Peguans was repulsed with loss. It was again attacked by the Peguans, aided by three English ships, and the Birmans were driven from their boats. They still, however, maintained their position on shore till their enemies retreated. In July 1756, Syriam was taken by assault, and its fall may be said to have decided the contest. As soon as the rainy season subsided, and the low and swampy country which lies between Pegu and Syriam had emerged from the inundations of the monsoon, Alompra ordered his general to advance towards Pegu with a strong body of troops. The whole army followed a few days afterwards, and in four days reached the city, marching through a wasted country. The city of Pegu was occupied by the royal family, and the principal nobles of the nation. Alompra, according to the usual tactics of the Birmans, had recourse for the reduction of the city to blockade, rather than to the doubtful attempt of an assault. The Peguans, reduced to the utmost straits, were forced at last to surrender the city, which was given up to indiscriminate plunder; a decisive blow was thus given to the independence of Pegu; and Alompra, improving his victory, proceeded to bring into subjection the countries to the eastward, including the fertile districts between Pegu and the three pagodas, which were the ancient boundaries of Pegu and Siam. From this period the kingdom of Pegu has been incorporated with the Burmese dominions; and the Peguans, though occasionally rebelling, have never been able to shake off their oppressive yoke.

Pegu, the capital of the former kingdom of Pegu, situated on the Sitang, formerly a large and populous city, the extent of which may be still traced in the ruins of the walls. These were composed of brick badly cemented with clay, about thirty-five feet thick, with small equidistant bastions about 300 yards asunder. The ditch was about sixty yards in breadth, and ten or twelve feet in depth. The ancient city was razed to the ground by the conqueror Alompra, when he took it in 1757, with the exception of the temples, which are numerous; and of these, the great temple of Shoomandoo has alone been renewed and kept in repair. Europeans who visited this city in the year 1600, describe it as a place of great splendour, the streets spacious, and running in a straight line from gate to gate. The king's palace, with walls and ditches, stood in the middle of the town, built like a fortress; but the interior apartments were all composed of wood with gilt roofs, and the population amounted to 150,000.

As stated in the former article, orders were issued by the Birman monarch to rebuild the ruined city; and the governor of the province was induced to quit Rangoon and to make Pegu his future residence. These measures so far succeeded that a new town was built on the site of the ancient city; and the inhabitants, consisting chiefly of the priests, the followers of the court, and a few poor families, now amount to 7000. The great proportion of the former inhabitants are either extinct, or have been dispersed over the whole extent of the empire. The new city of Pegu is built on the plan of the former city, and occupies about one half of its area; it is fenced round by a stockade from ten to twelve feet high. The plan of the new town is that of one main street running east and west, crossed at right angles by two smaller streets not yet finished. At each extremity of the principal street there is a gate in the stockade, which is defended by a wretched piece of ordnance and a few musqueteers. There are two inferior gates on the north and south sides of the stockade. The streets are spacious, like those of most Birman towns; and the town is paved with brick, large supplies of which are found in the old ruins. All the houses, even those of the meanest classes, are raised from the ground, either on wooden posts or bamboos, according to the size of the building. The monasteries of the priests, and the habitations of the higher classes, are raised to the height of six or eight feet. The houses are all made of mats or sheathing boards, the use of brick or stone in private buildings being prohibited by a royal edict. The dwellings being composed of such combustible materials, the inhabitants are in continual dread of fire; and almost every house has earthen pots filled with water on the roof; and a class of firemen perambulate the streets day and night. The roofs are lightly covered; and, as an additional precaution against fire, at each door stands a long bamboo, with an iron hook at the end, to pull down the thatch. There is also another pole with a grating of iron, to suppress flame by pressure. The house of the maywoon or viceroy is a spacious building, possessing, however, few ornaments; gilding is forbidden to all subjects in the Birman empire; few have even the liberty to paint the pillars of their house, or to use lacker; and the naked wood gives an unfinished appearance to their houses, however roomy or well adapted to their purposes. The great object that attracts attention in Pegu is the noble edifice of Shoomandoo or the Golden Supreme. This extraordinary pile of building is erected on double terraces, one raised upon another; the lower and greater terrace, about ten feet above the natural level of the ground, forming an exact parallelogram; the upper and lesser terrace is similar in shape, and rises about twenty feet above the lower terrace, or thirty feet above the level of the ground. These terraces are ascended by flights of stone steps. The temple is pyramidal, composed of brick and mortar, without excavation or aperture of any sort; it is octagonal at the base and spiral at the top, and each side measures at the base 162 feet. This breadth diminishes abruptly, so that its form has been compared to that of a speaking trumpet. The extreme height of the edifice from the level of the country is 361 feet; and on the top is an iron tee or gilded umbrella, seen on every building in the Birman dominions, fifty-six feet in circumference. All around the steps or ascent are placed innumerable marble images of Gaudama their saint. The Rahaans or attendant priests assert that the foundation of this temple was laid two thousand years ago, and that it was brought to its present state of magnificence by successive monarchs. On the south-east angle of the upper terrace are two handsome saloons, supported on pillars sixty feet in length by thirty in breadth; at each angle of the interior and higher terrace is a temple sixty-seven feet in height, resembling in miniature the great temple; and in front are four gigantic representations in masonry of Palloo the evil genius, half beast, half man, seated on his hams, with a large club on the right shoulder. Long. 96. 12. E. Lat. 17. 10. N.

PEIHO, a considerable river of China, in the province of Pe-che-lee. It has its rise on the borders of Tartary, and in its course northwards passes within a few miles of the capital, maintaining its communication, by the great canal, with the Yellow Sea, into which it discharges itself in lat. 39. 3. N. The country through which it flows is mostly a dead flat, and the tide is perceptible 400 miles from its mouth.

PEINA, a city of the kingdom of Hanover, in the province of Hildesheim, the capital of a bailiwick of the same name, situated on the river Fuse. It is surrounded with walls, and contains a castle used now as a workhouse, a Catholic and a Lutheran church, a capuchin monastery, 440 houses, and 3460 inhabitants, employed chiefly in spinning and weaving linen goods, and in agriculture. Long. 10. 6. 31. E. Lat. 52. 19. 34. N.

PEINE Forte et Dure (Lat. *pœna fortis et dura*) signifies a special punishment inflicted on those who, being arraigned of felony, refuse to put themselves on the ordinary trial, but stubbornly stand mute. It is vulgarly called *pressing to death.*

PEINGHEE, a town in the Birman empire, on the western side of the Irrawaddy. The teak timber grows in the western mountains, which are in sight, in great abundance, and is carried to Rangoon, whence it is exported to the British territories. Here also ships are built, although the distance from the Rangoon, including the windings of the river, is 150 miles. Long. 94. 50. E. Lat. 18. 31. N.

PEIRCE, James, an eminent dissenting minister, born at Wapping, London, in the year 1674. He was educated at Utrecht and Leyden; after which he spent some time at Oxford, in order to enjoy the benefit of frequenting the Bodleian Library. He then for two years preached the Sunday-evening lecture at the meeting-house in Miles Lane, London, and afterwards settled at Cambridge. In 1713 he was removed to a congregation at Exeter, where he continued until the year 1718; when the Calvinists amongst the dissenters having proposed a subscription to articles of faith, which were to be signed by all the dissenting ministers in the kingdom, he refused, and was consequently ejected from his congregation. Upon this, a new meeting was opened at Exeter, of which Mr Peirce continued minister till his death in 1726. He was a man of strict virtue, exemplary piety, and great learning; and he wrote, 1. Exercitatio Philosophica de Homœmeria Anaxagorea; 2. Thirteen pieces on the Controversy between the Church of England and the Dissenters; 3. Ten pieces on the Controversy about the Ejectment at Exeter; 4. Six pieces on the Doctrine of the Trinity; 5. A Paraphrase and Notes on the Epistles of St Paul to the Colossians, Philippians, and Hebrews; 6. An Essay in favour of giving the Eucharist to Children; and, 7. Fourteen Sermons.

PEIRESC, Nicolas Claude Fabri, born in 1580, was descended from an ancient and noble family, which had been originally established at Pisa in Italy. At ten years of age he was sent to Avignon, where he spent five years in the Jesuits' college, studying what in Scotland and on the Continent is called *humanity.* From Avignon he was, in 1595, removed to Aix, and entered upon the study of philosophy. In the interim, he attended the proper masters for dancing, riding, and handling arms, in all which, though he performed the lessons regularly, it was with reluctance; for this being done only to please an uncle, whose heir he was to be, he never practised by himself, esteeming all the time lost which was not spent in the pursuits of literature. During this period, his father being presented with a medal of the Emperor Arcadius, which had been found at Belgenser, Peiresc begged the favour of it; and, charmed with deciphering the characters in the exergue, and reading the emperor's name, he carried the medal, in a transport of joy, to his uncle, who for his encouragement gave him two more, together with some books upon the subject. This is the epoch of his application to antiquities, for which he became afterwards so famous. In 1596, he was sent to finish his course of philosophy under the Jesuits at Tournon, where he turned his attention particularly to cosmography, as being necessary to the understanding of history; abating, however, nothing of his application to antiquity, in which he was assisted by Petrus Rogerus, one of the professors, and a skilful medallist. Nor did he neglect the study of humanity in general, in which he was the master and instructor of a brother who lived with him. But to do all this he was obliged to sit up late at night; and as he was naturally of a feeble constitution, so much labour and attention increased the weakness of his stomach, formerly contracted, and for which he had used a kind of digestive powder. Being recalled by his uncle in 1597, he returned to Aix, and there entered upon the study of the law, which he prosecuted, however, so as to find leisure to visit and converse frequently with Bagarr, a most skilful antiquary, who was afterwards master of the jewels to Henry IV.

The following year he went again to Avignon, to carry on his course of law under one David, who being also well skilled in antiquities, was pleased to see Peiresc join this study to that of the law. But Ghibertus of Naples, auditor to Cardinal Aquaviva, fed his curiosity the most, in showing him some rarities, such as he had never seen before. Having now spent almost three years in Italy, he began to prepare for his departure, and in the end of 1602, having packed up all the rarities, gems, and other articles which he had procured, and despatched them to Marseilles, he left Padua, and, crossing the Alps of Geneva, proceeded to Lyons. From Lyons he went to Montpellier, to improve himself in law under Julius Parius. From Montpellier he despatched more rarities to his uncle, and arrived at Aix in November; but having brought Parius along with him, he obtained leave to return in a few days to Montpellier. He accompanied Parius back again, and under him continued pursuing his legal studies till the end of 1603, when he returned to Aix, at the earnest request of his uncle, who, having resigned to him his senatorial dignity, had ever since the beginning of the year laboured to get the king's patent. The degree of doctor of laws was a necessary qualification for this dignity. Peiresc, therefore, having performed the usual exercise, took that degree, in January 1604, when the patent was given to the senate, and ordered to be recorded; yet Peiresc procured leave not to be presently entered into the list of senators. The bent of his inclination was not so much to business as to advancing arts and sciences, and assisting all the promoters of learning. For this purpose, he resolved to lead a single life; so that when his father had concluded a match for him with a respectable lady, he begged to be excused.

In the year 1605 he accompanied Varius, first president of the senate at Aix, who was very fond of him, to Paris, whence, having visited every thing curious, he, in 1606, crossed the Channel to England, in company with the king's ambassador. He was very graciously received by King James I.; and having seen Oxford, and visited Camden, Sir Robert Cotton, Sir Henry Saville, and other learned men, he passed over to Holland. After visiting the several towns and universities, with the literati in each, he passed through Antwerp to Brussels, and thence returned to Paris to witness the ceremony of the Dauphin's baptism, which was solemnized on the 24th of August 1606.

In 1629 he began to be much tormented with strangury and hæmorrhoids; and in 1631, having completed the marriage of his nephew Claudius with Margaret Alresia, a noblewoman of the county of Avignon, he bestowed upon him the barony of Rians, together with a grant of his senatorial dignity, only reserving the function to himself for three years. But the parliament not waiting for his surrender of it, he resented that affront so heinously, that in 1632 he procured letters patent from the king to be restored to the exercise of his office during five years longer, which happened to be till the time of his death; for, being seized, in June 1637, with a fever, which brought on a stoppage of urine, this put an end to his life, in the fifty-seventh year of his age.

The works which he published are, 1. Historia provinciæ Galliæ Narbonensis; 2. Nobilium ejusdem provinciæ Familiarum Origines, et separatim Fabriciæ; 3. Commentarii rerum omnium memoria dignarum sua ætate gestarum; 4. Liber de ludicris Naturæ operibus; 5. Mathematica et astronomica varia; 6. Observationes mathematicæ; 7. Epistolæ ad S. P. Urbanum VIII. Cardinales Barberinos, &c.; 8. Authores antiqui Græci et Latini de ponderibus et mensuris; 9. Elogia et Epitaphia; 10. Inscriptiones antiquæ et novæ; 11. Genealogia domus Austriacæ; 12. Catalogus librorum Bibliothecæ regiæ; 13. Poemata varia; 14. Nummi Gallici, Saxonici, Britannici, &c.; 15. Linguæ orientales, Hebræa, Samaritana, Arabica, Egyptiaca, et Indices librorum harum linguarum; 16. Observationes in varios auctores.

PEKIANGHO, a considerable river of China, in the province of Quangtong, having its origin on the southern side of the mountains by which that province is divided from Kiangsee. It forms part of the great navigable communication between Peking and Canton.

PEKING, or Pekin, a celebrated city of Asia, and capital of the great empire of China. It is built in the form of an oblong square, of which the four walls face the cardinal points, and enclose an area of about fourteen square miles, independently of the suburbs, which are very extensive. The walls are built of brick, and are thirty feet in height. In the south wall there are three gates, and in each of the other sides two, from which it is sometimes called the city with nine gates; but its usual name is *Peking*, or the Northern Court. The city is divided into two parts; namely, the old city, which is inhabited by the Chinese; and the new city or the imperial city, which is inhabited by the Tartars. It is in the shape of a parallelogram, and is about a mile in length from north to south, and three fourths of a mile from east to west. The middle gate on the south side opens into this space; and it is surrounded by a wall built of large red polished bricks, twenty feet in height, covered with a roof of tiles painted yellow and varnished. Here are contained the imperial palace and gardens, all the tribunals or public offices of government, and lodgings for the ministers, eunuchs, artificers, and tradesmen belonging to the court. Within the enclosure flows a winding rivulet, which being formed into canals, basins, and lakes, with artificial mounts, rocks, and groves, exhibits a lively imitation of the picturesque and the beautiful in natural scenery. The imperial palace of Yuen-mien, which is situated without the city, is even on a larger scale, the grounds being at least ten miles in diameter, and comprising an area of 60,000 English acres, laid out, like the grounds in the palace within the walls, in representing all the great features of nature, namely, lakes, mountains, forests, rocks, and rivers, which are thrown together with an irregular boldness of style that has a striking effect. These grounds contain thirty distinct places of residence for the emperor, besides a village of considerable size. These buildings, however, are remarkable for their meanness, resembling rather cottages than palaces. Even the very dwelling of the emperor, and the grand hall of audience, when divested of their colour and gilding, are not much superior to the barns of an English farmer. Nor is any rule of proportion studied in the construction of these apartments. The length of the audience-hall is a hundred and ten feet, by forty-two in breadth, and the height is twenty feet. The ceiling is embellished with circles, squares, and polygons, and loaded with a great variety and glare of colours. The throne, placed in the recess, is adorned with exquisite carving. It is supported by rows of pillars painted red, and consists entirely of a wood resembling mahogany. Between the other two gates in the south and north walls run two streets in a straight line, four English miles in length, and about a hundred and twenty feet in breadth. These are crossed by one street of the same breadth, which runs from the gate of the eastern wall to the opposite gate on the west. There is another street which runs in the same direction; but it is interrupted in its progress by the north wall of the imperial city, round which it is carried. The cross streets, which branch off from the main streets at right angles, are merely lanes, being very narrow. They are all unpaved, and covered with sand and dust, but are frequently watered, and kept very clean. The houses are low, few being more than one story in height; not a chimney is to be seen rising above the ordinary level; and this circumstance, together with the regularity of the streets, all laid out in straight lines, give to the city the appearance of an encampment. None but the great shops have either windows or openings in the front wall, though most of them have a sort of terrace, with a railed balcony or parapet wall in front, ornamented with flowers, shrubs, or stunted trees. The principal streets have on each side a line of buildings, consisting entirely of shops and warehouses, in front of which the goods are displayed; and large wooden pillars are erected higher than the houses, on which are notified in gilt characters the nature of the goods to be sold, and the honest character of the dealers, and which are, besides, decorated with various-coloured flags, and streamers and ribands from top to bottom, exhibiting the appearance of a line of shipping dressed in the colours of all the different nations of Europe. Nor are the sides of the houses less brilliant in the several colours in which they are painted, consisting generally of sky-blue or green, mixed with gold; and amongst the articles which make the most splendid show are the coffins for the dead, and the funeral biers, which vie in their expensive trappings with the marriage cars. Barrow, who visited China with Lord Macartney's embassy, gives a lively description of the animated scene which the first *coup d'œil* of the streets presented to the view. "The multitude of moveable workshops," says Mr Barrow, "of tinkers and barbers, cobblers and blacksmiths; the tents and booths where tea and fruit, rice and other eatables, were exposed for sale, with the wares and merchandise arrayed before the doors, had contracted the spacious street to a narrow road in the middle, just wide enough for two of our little vehicles to pass each other. The cavalcade of officers and soldiers that preceded the embassy; the processions of men in office, attended by their numerous retinues, bearing umbrellas, and flags, and painted lanterns, and a variety of strange insignia of their rank and station; different trains that were accompanying with lamentable cries corpses to their graves, and, with squalling music, brides to their husbands; the troops of dromedaries laden with coals from Tartary, the wheelbarrows and hand-carts stuffed with vegetables; occupied nearly the whole of this middle space in one continued line, leaving very little room for the cavalcade of the embassy to pass. All was in motion. The sides of the streets were filled with an immense concourse of people buying and selling, and bartering their different commodities. The buzz and confused noises of this mixed multitude, proceeding from the loud bawling of those who were crying their wares, the wrangling of others, with every now and then a strange twanging noise like the jarring of a cracked Jew's harp, the barber's signal made by his tweezers, the mirth and laughter that prevailed in every group, could scarcely be exceeded by the brokers in the bank rotunda, or the Jews and old women in Rosemary Lane. Pedlars with their packs, and jugglers and conjurers, fortune-tellers, mountebanks, quack-doctors, comedians and musicians, left no space unoccupied." Tartar women are commonly seen amongst the crowd, either walking or riding on horses, which they bestride like men. The Chinese women are, however, rigidly confined to the house in Peking, as in other parts of the empire.

Of the ornamental structures to be seen in Peking, the most remarkable are three singular erections at the four points where the great streets intersect each other, called triumphal arches, but which are rather monuments to the memory of distinguished characters, especially of those who have attained to extraordinary longevity. They are formed sometimes of stone, but generally of wood; and consist of a large central gateway, with a smaller one on each side, all covered with narrow roofs; and, like the dwelling-houses, they are splendidly painted, varnished, and gilt. Large characters of gold announce that each monument was erected in commemoration of some distinguished person, or of some interesting event.

The police of this capital is well regulated, and the public peace seldom disturbed. At certain distances, and at the end of every cross street, is placed a soldier, who keeps watch in a sentry-box; and few streets are without a guard-house. The proprietor or inhabitant of every tenth house is, besides, held responsible for the conduct of his nine neighbours; and is bound, on the appearance of any riotous conduct, to give intimation to the nearest guard-house. The soldiers also on guard go their rounds, and at intervals strike upon a short tube of bamboo, which gives a dull hollow sound, and which, Barrow mentions, prevented himself and other members of the British embassy from sleeping until they became accustomed to it. "The city," says Sir George Staunton, "partakes of the regularity and interior safety of a camp, but is subject also to its constraints. In the suburbs only public women are registered and licensed, though they are not numerous. The inhabitants of Peking are not remarkable for their cleanliness. There are no common sewers in the city to carry off the dirt and dregs that must accumulate amid such a large collection of people; and such are the singular and revolting habits of the people, that no kind of filth or nastiness is thrown into the streets to create an offensive smell: it is carefully stored up within the house in an earthen jar kept for the purpose; and when it is full, it is sold for manure, and carried off in small bored carts with one wheel, which supply the city with vegetables. The consequence of this filthy practice is, that a disgusting odour remains about all the houses the whole day long."

The walls by which the city is surrounded do not appear to exceed twenty-five, or at most thirty feet in height. They are flanked with square towers, placed at regular distances of about seventy yards each, with a small guard-house on its summit; and these towers project about forty feet from the line of the wall. The wall at its base is about twenty-five feet thick, and the width across the top within the parapets is twelve feet. The middle part, composed of the earth which had been dug out of the ditch, is kept together by two retaining walls, partly of brick and partly of stone. No cannon are mounted on the walls or bastions; but in the high building surmounting the gate, and which is several stories in height, the port-holes are closed with red doors, on the outside of which are painted representations of cannon, not unlike the sham ports in a ship of war.

The most exaggerated ideas were formerly entertained of the population of Peking. In the last century the Jesuit Grimaldi carried it to the amount of sixteen millions. According to the most accurate information that could be obtained by the embassy of Lord Macartney, the present population of Peking may be estimated at three millions. The low houses seem to be by no means adequate to so vast a population; but very little room is required for a Chinese family, especially amongst the middling and lower classes. A Chinese dwelling, surrounded by a wall six or seven feet in height, contains a whole family of three generations, with their respective wives and children. Still, with all these allowances, it is probable that this estimate of three millions, given by the Mandarins to the British embassy, is considerably exaggerated. Long. 116. 28. E. Lat. 39. 55. N.

PELAGIANS, a Christian sect who appeared about the end of the fourth or beginning of the fifth century. They maintained that Adam was by nature mortal, and, whether he had sinned or not, would certainly have died; that the consequences of Adam's sin were confined to his own person; that new-born infants are in the same situation with Adam before the fall; that the law qualified men for the kingdom of heaven, and was founded upon equal promises with the gospel; that the general resurrection of the dead does not follow in virtue of our Saviour's resurrection; that the grace of God is given according to our merits; and that this grace is not granted for the performance of every moral act, the liberty of the will, and information in points of duty, being sufficient. The founder of this sect was Pelagius.

PELAGIUS was a native of Great Britain, but whether of England, Scotland, or Wales, is as uncertain as it is immaterial. He was born towards the close of the fourth century, and educated in the monastery of Bangor, in Wales, of which he became a monk, and afterwards abbot. In the early part of his life he passed over to France, and thence proceeded to Rome, where he had the insolence to promulgate certain opinions different from those of the church. His morals being irreproachable, he gained many disciples; and the heresy he preached made so rapid a progress, that it became necessary for the pope to exert his power. To avoid the danger, Pelagius passed over to Sicily, in the year 409, attended by his friend and pupil Celestius. In 411 they landed in Africa, continued some time at Hippo, and were present at the famous conference between the Catholics and Donatists, which was held at Carthage in 412. From thence they travelled into Egypt, and from Egypt, in 415, to Palestine, where they were graciously received by John bishop of Jerusalem. In the same year Pelagius was cited to appear before a council of seventeen bishops, held at Diospolis. They were satisfied with his creed, and absolved him of heresy. The African bishops, however, being displeased with their proceedings, appealed to the Roman pontiff, who first approved, and afterwards condemned, the opinions of Pelagius; the latter, with his pupil Celestius, was publicly excommunicated; and all the bishops who refused to subscribe the condemnation of the Pelagian heresy were immediately deprived. What became of him after this period is entirely unknown; but it seems very probable that he retired to Bangor, and died abbot of the monastery of that place. He wrote, 1. Expositionum in Epistolas Paulinas, lib. xiv.; 2. Epistola ad Demetriadem de Virginitate; 3. Explanatio Symboli ad Damasum; 4. Epistolæ ad viduam duæ; and, 5. De Libero Arbitrio. These, and many other fragments, were scattered amongst the works of St Jerome. They were also collected by Garnerius, and published in *Append. Op. Mercatoris*, p. 373.

PELAIGHE, a town of Hindustan, tributary to the Mahrattas, and situated in the province of Agra, twelve miles north from Narwar. Long. 78. 8. E. Lat. 25. 51. N.

PELANDAH, a large village of Hindustan, in the Rajpoot territories, and province of Ajmeer, said to contain 1000 houses. It is seventy miles east-south-east from Jyenagur. Long. 76. 45. E. Lat. 26. 36. N.

PELANGY, a river in the island of Magindanao, on which the capital is situated, and here as broad as the Thames at London bridge.

PELASGI, or PELASGIANS, a very ancient people, of whom the historical inquirers in the Augustan age could find no trace amongst any race then subsisting, and about whom so many opposite opinions have been confidently maintained, and so much learning unprofitably accumulated, that it is difficult, if not impossible, to arrive at any distinct or satisfactory conclusion.

Disregarding that spurious philology which raises pretensions to knowledge concerning races whose annals have long since perished, we may, however, observe, that the people known by the name of Pelasgians are supposed to have originally occupied Greece, and to have penetrated into central Italy long before the establishment of the Hellenic colonies in Magna Græcia, that is, the southern portion of the Italian peninsula. Thus much seems to be admitted on all sides, because it is borne out by the concurring testimonies of ancient authors, who are agreed in almost nothing else, respecting either the origin or the migrations of this primitive race. The questions that have been most keenly agitated amongst the learned are, whether the Pelasgians were a different nation from the Hellenes, or the same people under a different denomination; and whether they were Scythians or Goths, as Mr Pinkerton contends, or a branch of some other distinctive race of men, as others have maintained. The discussion of these matters, we are well aware, is rather a subject of antiquarian research and learned curiosity than one calculated to afford either amusement or instruction to the generality of readers; but as it has called forth displays of profound erudition, and elicited much ingenuity, a concise and comprehensive view of the actual state of the dispute may not be altogether out of place in a work which has for its object to embrace the whole cycle of human knowledge and research, even without reference to the secondary considerations of immediate interest or utility.

Mr Pinkerton, in strict accordance with his general theory, maintains that the Pelasgians were Scythians, and also that the Hellenes or Greeks were Pelasgians, or, in other words, of Scythian or Gothic origin. He argues, that as the Pelasgians certainly descended from the north-east into Greece, and thus came from, or at least through, a country which had been overspread by the Scythians long before the period of their descent into Hellas, it may be inferred that they were of the same origin and race with the inhabitants of Thrace, Thessaly, and the other countries where they first made their appearance; a conclusion, we may observe, which, whether it be well or ill founded, does not necessarily follow from the premises, because the circumstance of a roving or migratory tribe passing through a particular country in its progress towards other settlements, by no means warrants the supposition either of identity or diversity of origin with reference to the prior inhabitants of such country. Mr Pinkerton, however, contends, that at a very early period Pelasgian settlements were established on the Hellespont; that, in the days of Homer, and even much later, a district in Thessaly was named Pelasgia; that the people of Macedonia were anciently called Pelasgians; that the Thracians, who, under Eumolpus, colonized Attica, were by Herodotus denominated Pelasgians; and that Plutarch describes the same people as a roving or migratory race, who, having subdued the inhabitants, settled in the countries they had conquered,—a description which, he thinks, can only apply to the Scythians. Besides, Herodotus, Thucydides, and Strabo, all state that the Pelasgians came originally from Thessaly into Greece; and as Thessaly was anciently accounted a part of Thrace, Mr Pinkerton thence concludes that the Pelasgians were Thracians, that is, Scythians or Goths. According to him, ancient Pelasgia included Macedonia, Epirus, and afterwards the country which in later times was called Hellas or Greece; and he follows the opinion of the majority of the learned in holding that *Pelasgi* and *Hellenes* were but different names for one and the same people.

This assumed identity necessarily implies, that if the Pelasgians were Scythians or Goths, so also were the Hellenes. Mr Pinkerton, however, devotes a separate section to the discussion of this point, and accumulates a number of authorities in support of his position, that the Hellenes were Scythians. That the Hellenes were originally a small tribe in Thessaly, is, he conceives, proved by the authority of Thucydides, which is confirmed by that of Herodotus and Strabo. The same authors make it equally clear that the Thessalians were Thracians, a people who extended as far down as Phocea; whilst later authorities state, that all the people south of the Hellespont, including the Macedonians and Greeks, were of Scythian origin. Besides, the language and manners of the whole of Hellas, from Thrace to the Ionian Sea, were, according to Pinkerton, Thracian or Scythian, that is, Gothic. No ancient writer has mentioned, nor even hinted at, any diversity of speech, save as to refinement, between Peloponnesus, Attica, Epirus, Thessaly, Macedonia, and Thrace. In Homer's time the name of barbarians was not applied to the Thracians, who appear to have spoken the same language with the Hellenes; and Diodorus Siculus states that the *Scythæ Hyperborei*, or most distant Scythians, used a form of speech akin to that of Athens and Delos, in other words, Pelasgic or Gothic. Anacharsis, the Scythian philosopher, who had learned the language and studied the manners of the Greeks, pronounced them Scythian;[1] and even Xenophon bears indirect testimony to the accuracy of this judgment. The similarity between the Greek and the Gothic language is attested by Ovid;[2] and, in modern times, Salmasius, Junius, Casaubon, Ihre, Jamieson, and many other learned scholars and antiquaries, have pronounced the Greek and the Gothic to be merely dialects of the same original language, though some of them have fallen into the mistake of deriving the latter from the former. In corroboration of the same general view, Bibliander states, that in the German, which is a dialect of the Gothic, eight hundred out of two thousand radicals are common to the Greek and Latin, as well as the German; and as to the Latin, every scholar knows that, originally, it was merely the Æolic dialect of the Greek. But of all marks or proofs of the origin of nations, that of language is the most certain; and from this remarkable coincidence in radical structure, taken in connection with the other circumstances adverted to by him, Mr Pinkerton concludes, that the Pelasgians, the ancestors of the Greeks, afterwards called Hellenes, from the leader of the last tribe that arrived, were originally settled in Macedonia and Thessaly; that they were Thracians, and that the Thracians were all Scythians or Goths.

The Pelasgians or Hellenes were, according to our author, much improved by the situation of Greece, their new settlement, which, being surrounded by the sea on every side except the north, proved a centre of attraction for small colonies from Egypt and Phœnicia, countries celebrated for their early civilization. Letters were imported, tillage was introduced, and the arts of life began to be cultivated. But the colonies to which this branch of the Scythians were mainly indebted for these advantages appear to have all adopted the Pelasgic or Hellenic language, and conformed to the Pelasgic or Hellenic rites and customs; and it might even be shown that the Greek mythology was only an improved version of that which obtained in ancient Scythia, the gods being mostly deified heroes or princes. Many ideas of the Greek mythology may also be found in the Gothic, though in a form far less polished and refined. The most ancient Greek poets, it is well known, were the sole teachers of the people; they were the first who, by blending allegory with popular superstition and legendary romance, composed systems of theogony and mythology. But these early poets and teachers were all of Thrace. Linus, Orpheus, Musæus, Thamyris, and Eumolpus, were Thracians, and consequently Scythians or Goths, familiar with the ancient traditions of the race to which they belonged. This circumstance has been remarked by Eustathius, and it is certainly not a little singular, in reference to the subject before us. In a word, it appears that the Greeks originally "Scythicised," as Anacharsis called it, that is, followed the customs, manners, and traditions of the Scythians; but being improved by the introduction of foreign arts and the admixture of foreign settlers, they soon assumed a character quite distinct from that of their northern progenitors, and at length attained to the highest degree of civilization and refinement.

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[1] Εμοι δι, φησιν ὁ Αναχαρσις, παντες Ἑλληνες Σκυθιζουσι. (Clemens Alexand. *Strom.* lib. i. p. 364.)

[2] Exercent illi *sociæ* commercia *linguæ*,
Graiaque quod Getico victa loquela sono est. (*Tristia*, lib. v. 10.)

Such is a condensed abstract of Mr Pinkerton's system, which, whether it be well founded or not, has at least the peculiar merit of being clear, distinct, and intelligible. We cannot say as much, however, for the speculations of almost any other writer who has treated of this subject, and least of all for those of Niebuhr, whose chapter on the Pelasgians is the most obscure, and therefore the least interesting, in his History of Rome. The fact seems to be, he had no settled views on the subject; and though he discusses his authorities with great ability, he has somehow failed to extract from them any definite or general results. We shall endeavour, as we best can, however, to give the reader some general notion of what this celebrated author has written respecting a race which has a double claim to attention, from its connection with the ancient history of both Greece and Italy.

According to Niebuhr, the Pelasgians were a different nation from the Hellenes, and had a language of their own, which was peculiar, and not Greek. This is his general principle, to which he repeatedly recurs, though without explaining how he arrived at such a conclusion. Yet, notwithstanding the difference here supposed, he thinks it probable that there was an essential affinity between them, from the ease with which so many Pelasgian nations ripened into Hellenes, and from the Latin containing an element which is half Greek, and admitted to have been of Pelasgic origin. But it is not easy to see how this total difference and essential affinity are to be reconciled, or how Latin could have contained an element half Greek and of Pelasgic origin, if the language of the Pelasgians was peculiar, and not Greek. Herodotus says that in process of time they came to be accounted Greeks, and that from them the Grecian theology was derived; circumstances which certainly serve to indicate the essential affinity to which Niebuhr refers. But the difficulty still remains to account for the diversity in nation and language which is predicated of the same people. It is perfectly true, as Niebuhr remarks, that the Pelasgians, in that part of history to which our monuments and traditions reach, were in a state of ruin and decay. They seemed a race that had outlived a period of other forms, looking like strangers left to languish in an altered world; and this is the reason why their history is shrouded in such obscurity. The old traditions spoke of them as a race pursued by the heavenly powers with never-ending calamities; and the traces of their abode in widely-distant regions probably gave rise to the notion that they roamed about from land to land in order to escape from these afflictions. But, surrendering to the poets the fable of their wanderings, Niebuhr thinks that he who rightly interprets the scattered hints of tradition, and searches for traces of their diffusion, will recognise in this singular people one of the very greatest nations of ancient Europe, who in the course of their migrations spread themselves almost as widely as the Celts, though in a manner still less known, and leaving even fewer memorials of their existence.

The learned historian, however, has not thought fit to apply his erudition and critical sagacity to the elucidation of this important point, which would have been a thousand times more instructive and interesting than the most elaborate discussion of authorities. He seems to have been perplexed with the discrepancies he encountered, and the difficulties with which he was beset, especially in reference to the Pelasgian tribes which originally penetrated into Italy; but having adopted no hypothesis, and hit upon no general principle, he has left the origin and history of the Pelasgians as obscure as ever; nor has he even succeeded in disentangling that part of the question which relates to their settlement in Italy, whither they are said to have carried the language of Greece in its most ancient or Æolic form. The boldness of speculation by which his disquisitions on other parts of his subject are characterized, is here altogether awanting. Instead of grappling at once with the difficulty, like Pinkerton, and thus imparting method and system to his investigations, he fritters away the whole question in detail; leaving no distinct impression on the mind, and disappointing the expectations which he had himself raised. The only leading ideas we have been able to detect are those which we have already mentioned. The important considerations of language and race enter not as elements into the investigation; and he at last concludes by reiterating the paradox with which he had commenced.

"The facility," says he, "with which they were moulded into Greeks, is a characteristic of the Pelasgian tribes, and a main cause of the dissolution and extinction of the nation. It is natural to view it as resulting from the affinity between the two races, which yet were not on that account the less essentially different; and such I believe to have been the case: yet we may observe a magical power exercised by the Greek language and national character over foreign races that came in contact with them, even where no such affinity can be conceived. The inhabitants of Asia Minor hellenized themselves from the time of the Macedonian conquest, almost without any settlements amongst them of genuine Greeks; Antioch, though the common people spoke a barbarous language, became altogether a Greek city; and the entire transformation of the Syrians was averted only by their oriental inflexibility. Even the Albanians, who have settled as colonies in modern Greece, have adopted the Romaic by the side of their own language, and in several places have forgotten the latter. It was in this way only that the immortal Suli was Greek; and the noble Hydra itself, the destruction of which we shall perhaps have to deplore, is an Albanian settlement."

This is, no doubt, very ingenious; but is it sound? To say nothing of the difficulty of conceiving the co-existence of an essential affinity with an essential difference, the cases here put are those of more refined nations in contact with such as are less so, and the consequent influence of the former upon the latter. But where is the evidence that the Greeks stood in this relation to the Pelasgians? Has it been shown by our author that the latter were really a different people from the Hellenes? Or, if so, which was the more ancient? Were there Greeks, properly so called, in Greece anterior to the arrival and settlement of the Pelasgians in that country? The latter have generally been supposed the most ancient inhabitants of the country; and it is certain that the name of Hellenes or Greeks is of later origin. The alleged facility with which the Pelasgian tribes were moulded into Greeks must therefore be explained on some principle different from that assumed by Niebuhr from inapplicable analogies. According to Pinkerton, this facility arose from the simple circumstance that the Pelasgians and Hellenes were in reality one and the same people.

(A.)

PELATÆ were those free-born citizens amongst the Athenians, who by poverty were reduced to the necessity of serving for wages. During their servitude they had no vote in the management of public affairs, from having no estate to qualify them; but this restriction was removed whenever they had released themselves from their servile situation, which they were allowed to do when able to support themselves. Whilst they continued servants, they had also a right to change their masters. We find them sometimes distinguished by the name of *Thetæ*.

PELAUDAH, a large village of Hindustan, in the Rajpoot territories, and province of Ajmeer, containing 1000 houses. It is seventy miles east-south-east from Jyenagur. Long. 76. 45. E. Lat. 26. 36. N.

PELEG, son of Eber, was born in the year of the world 1757. The Scripture says his father gave him the name of Peleg, signifying division, because in his time the earth began to be divided (Gen. xi. 16; x. 25); whether it was that Noah had begun to distribute the earth amongst his descendants, some years before the building of Babel, or that Peleg came into the world the same year that Babel was begun, and at the division of languages, or that Eber by a spirit of prophecy gave his son the name of *Peleg* some years before the tower of Babel was begun, is not absolutely certain. That which perplexes the interpreters is, that Peleg came into the world not above a century after the deluge. But it would seem, that the number of men in existence was not then sufficient for such an undertaking as that of Babel. In the next place, Joktan the brother of Peleg had already thirteen sons at the time of this dispersion, which happened after the confusion of Babel (Gen. x. 26, 27, 28). But Peleg being born in the thirty-fourth year of Eber (Gen. xi. 16), it is impossible his brother Joktan should have had such a number of children at the birth of Peleg. It would seem, therefore, that he was not born at the time of the dispersion. To this it may be answered, that Moses has there enumerated the names of the thirteen sons of Joktan (in Gen. x. 26) by way of anticipation, though they were not born until some time after the confusion at Babel; but as they possessed a very large country, it was convenient to take notice of them, and to name them amongst the other descendants of Noah, who divided the provinces of the East amongst themselves. However this may have been, at the age of thirty years Peleg begat Reu, and died at the age of 239.

PELETHITES. The Pelethites and Cherethites were famous under the reign of David. They were the most valiant men in the army of that prince, and guarded the person of the king.

PELEUS, in fabulous history, a king of Thessaly, son of Æacus, and Endeis, the daughter of Chiron. He married Thetis, one of the Nereids, and was the only mortal man who had ever married an immortal. He was concerned in the murder of his brother Phocus, and was therefore obliged to leave his father's dominions. He fled to the court of Eurytus the son of Actor, who reigned at Phthia, or, according to the opinion of Ovid, the truth of which is questioned, to Ceyx king of Trachinia. He was purified of this murder by Eurytus, with the usual ceremonies, and the king gave him his daughter Antigone in marriage. After this, when Peleus and Eurytus went to the hunting of the Caledonian boar, the father-in-law was accidentally killed by an arrow which his son-in-law had aimed at the beast. This unfortunate action obliged him to withdraw himself from the court of Phthia, and he went to Iolchos, where he was also purified of the murder of Eurytus by Acastus, the king of the country. His residence at Iolchos was short. Astydamia, the wife of Acastus, fell in love with him; but when she found him insensible to her passionate declarations, she accused him of attempts upon her virtue. The king her husband partly believed the accusations of his wife, but, not willing to violate the laws of hospitality, by putting his guest instantly to death, he ordered his officers to conduct him to Mount Pelion, on pretence of hunting, and there to tie him to a tree and leave him a prey to the wild beasts of the place. The orders of Acastus were faithfully obeyed; but Jupiter, knowing the innocence of his grandson Peleus, ordered Vulcan to set him at liberty. As soon as he had been delivered from danger, Peleus assembled his friends in order to punish the ill treatment which he had received from Acastus. He took Iolchos by force, drove the king from his possessions, and put to death the profligate Astydamia. On the death of Antigone, Peleus made love to Thetis, of whose superior charms Jupiter himself had been enamoured. His pretensions were rejected; for as he was but a mortal, the goddess fled from him with the utmost abhorrence, and, the more effectually to evade his inquiries, she generally assumed the shape of a bird, or a tree, or of a tigress. Peleus's passion was inflamed by refusal. He offered a sacrifice to the gods; and Proteus informed him, that to obtain Thetis he must surprise her whilst she was asleep in her grotto, near the shores of Thessaly. This advice was immediately attended to; and Thetis, unable to escape from the grasp of Peleus, at last consented to marry him. Their nuptials were celebrated with the greatest solemnity, all the gods attending and making them each the most valuable presents. The goddess of Discord was the only one of the deities who was absent, and she punished this seeming neglect by throwing an apple into the midst of the assembly of the gods, with the inscription of *Detur pulchriori*. The fruit of this marriage was the celebrated Achilles, whose education was early intrusted to Chiron the Centaur, and afterwards to Phœnix, the son of Amyntor. Achilles, it is well known, went to the Trojan war, at the head of his father's troops; and Peleus gloried in having a son who was superior to all the Greeks in valour and intrepidity. His death, however, was the source of great grief to Peleus; but Thetis, to comfort her husband, promised him immortality, and ordered him to retire into the grottos of the island of Leuce, where he should see and converse with the manes of his son. Peleus had by Antigone a daughter called Polydora.

PELEW ISLANDS, or PALAOS, a cluster of islands, mostly small, in the western part of the Pacific Ocean, situated between the Philippine and the Caroline Islands, and chiefly between the seventh and eighth degrees of north latitude, and the 134th and 135th of east longitude. These islands are eighteen in number, and their names are, Oroolong, Emungs, Emilleguc, Artingal, Corooraa, and Pelelew. These islands were first visited by the Spaniards from the Philippines, and received from them the appellation of the Palaos Islands, from the tall palm trees with which they are covered, and which at a distance have the appearance of ships' masts, as the term indicates. The largest of these islands is named Baubelthanap, and is about sixty miles in circumference; the smaller islands are to the south. The latter are well covered with trees of various kinds and sizes; some of them of the largest dimensions, and sufficient for forming a canoe capable of holding thirty persons. Amongst the variety of trees found here is the ebony, and a tree from which, when pierced by a gimblet, there exudes a thick white liquid of the consistence of cream. A species of tree also grows here, the sap of which blisters the skin. There is another singular tree, the branching of which is not unlike our cherry-tree; but its leaves resemble the myrtle. It has no bark, having only an outward coat about the thickness of a card, darker than the inside, though equally close in texture. It has the colour of mahogany in the interior, and is so extremely hard that no tool can work it. The other trees are the cabbage-tree, and a tree the fruit of which resembles the almond; the carimbola, and the wild bread-fruit tree; the cocoa-nut tree, the fruit of which is one of the chief articles of subsistence; and the betel-nut tree, which is in great abundance. Plantains, bananas, oranges, lemons, and sugar-canes, abound; likewise the turmeric, which the natives use as a dye, and with which they stain their skins. On none of these islands, when they were visited by the English, was there any kind of grain, or any quadruped except some brownish-gray rats, which ran wild in the woods, and a few lean cats, which were seen in some of the houses, and had probably escaped to the shore from some wreck or drift-wood. The common domestic fowls, such as cocks and hens, abound in the woods, though they are not domesticated; and, previous to the arrival of the English, they were not used for food by the natives, who reared pigeons for this purpose. Along the shores fish in great variety are found, with many shell-fish, particularly the large Kima cockle, which they procure by diving, and which, like other barbarous nations, they eat raw. Many of the other birds are distinguished alike by the beauty of their plumage and the variety and melody of their notes. There were several small birds of very melodious notes, especially one whose notes resembled those of a flageolet, and which sings morning and evening.

These islands, when seen from the sea, appear of a rugged mountainous aspect, and covered with wood; the interior parts being mountainous, and the valleys extensive and beautiful, opening into prospects of picturesque beauty. A reef of coral surrounds the shore, which is about five or six leagues broad, and in no case less than three. The soil is in general rich, and produces luxuriant herbage, which, as there is no cattle to eat it, grows high, and is scorched and burned with the heat of the sun. The climate, as in all tropical countries, is divided into the two seasons, the wet and the dry. There is nothing in these islands which deserves the name of a river; and the inhabitants derive their supplies of fresh water from small rivulets and ponds.

From the accounts given of these islands by Captain Wilson, commander of the Antelope packet, in the service of the East India Company, who was wrecked on them, and by other navigators, the inhabitants appear to have made but little progress in civilization. They are not, indeed, as they had been represented, irreclaimable savages, inhuman and barbarous, and feeding on human flesh; but, on the contrary, hospitable, friendly, and humane in their dispositions, though ignorant of the arts and manners of civilized life. They are, however, industrious, and every part of the island bears marks of cultivation. Yams and cocoa-nuts are the chief articles of subsistence, and to the rearing of these their attention was chiefly directed. They are a stout and well-made people, rather above the middle stature; and their complexions are not black, though of a deeper shade than the Indian copper-colour. They have long flowing hair, rather disposed to curl, which they form into one large loose coil round their heads. Some of the women, who have remarkably long hair, allow it to hang down their backs. The men go entirely naked; the women wear a slight covering of two little aprons, or rather thick fringes, one before and one behind, about ten inches deep and seven wide; these are made of the husks of the cocoa-nut, stripped into narrow slips, and dyed with different shades of yellow. Both men and women have the savage practice of tattooing, which operation takes place when both sexes arrive at maturity. One ear of the men is bored, and in the women both ears, and beads are worn in the perforated ear by the men; but the women put some leaf through, or an ear-ring of tortoise-shell inlaid. They also perforate the cartilage between the nostrils in both sexes, through which they frequently put a little sprig or blossom of some plant or shrub that pleases their fancy. Like most barbarous nations, both sexes are expert swimmers, and appear to be as perfectly at ease in the water as on land. In diving their skill is also remarkable; and the men, if they saw any thing at the bottom of the sea which attracted their attention, would instantly jump overboard and bring it up. They mix no salt nor any other seasoning in any thing they eat; and the milk of the cocoa-nut forms their usual beverage. They had no method of measuring time but by the height of the sun, though they had some knowledge of the stars, having names for several of them, which they pointed out to their English visitors. Their houses were of a rude construction. They were raised about three feet from the ground, and placed on large thick and oblong stones, as if cut from the quarry. Their fishing-tackle was, however, well manufactured. The hooks were made of tortoise-shell; and their twine, their cord, and all their fishing-nets, were well manufactured from the husks of the cocoa-nut. They form the mats on which they sleep, and which they throw over them when at rest, out of the plantain leaf. They use the plantain leaf at their meals instead of a plate; the shell of the cocoa-nut they polish very nicely, and it serves them as a cup to drink out of. Their best knives are made of a piece of mother-of-pearl oyster-shell. They make vessels of earthen ware, in which they boil their fish and yams; and their hatchets are made of the Kima cockle ground to a sharp edge. Their principal weapons are spears twelve feet long, made of bamboo, pointed with some hard wood, and darts and slings. They carry on a maritime warfare with each other in canoes, which they make from the trunk of a tree, with an outrigger, and furnished with lateen sails made of mattine.

The government of these islands is monarchical. The king has the supreme authority, and, though divested of all external decorations of royalty, he is honoured with every mark of personal distinction. The nobles approach him with the greatest respect; and his common subjects, whenever they pass him, or have occasion to address him, use every mark of the meanest servility, crouching towards the ground in his presence, or even before any place where he is supposed to be. The officer who approaches nearest to the king in power is his brother, who is generalissimo of all the forces. The king is always attended by a particular officer, who does not appear to possess any hereditary, but rather a delegated authority. He is first consulted in all public affairs, and has other marks of high dignity; but whether his office and character were religious or civil, the English could not exactly learn. Polygamy prevails in these islands, but in general the natives have not more than two wives, though the king had five, who lived in separate dwellings. They have little or no religion, and no outward observances that the English could perceive whilst they resided amongst them. The king became much attached to the English who were shipwrecked on these islands, and showed them great kindness. Indeed, so highly did he esteem Captain Wilson, that he intrusted his second son, Prince Lee Boo, to his care, to accompany him to England. This young prince was of the most amiable dispositions, anxiously desirous of knowledge, and capable of receiving it. He died of the small-pox, at Captain Wilson's house in London, in 1784, at the age of about twenty years. In return for the kindness shown by Abba Thulle, the prince of Pelew, to the crew of the Antelope wrecked on the island of Oroolong in 1783, the East India Company sent him, in the year 1791, a present of four young cows in calf, two young bulls from Sebojee, and ten ewes and two rams of the Bengal breed, eight she-goats and two rams of the Surat breed, with sows, boars, geese, ducks, hens, and turtle-doves, besides European swords and hardware, arms, and ammunition. In 1791, the captain of the Panther, a Bombay cruizer, was so much pleased

Pelicondah
||
Pelletier.

with the manners of the natives, that he resigned his command, with a view of spending the remainder of his days amongst them. But he soon wearied of being amongst savages, and returned in his pinnace to Macao. Several Europeans have been in the habit of residing here for the purpose of collecting biche de mer, tortoise-shell, and shark fins, for the China market. The Jesuits of Manilla, in the Philippines, endeavoured, in 1696, to reduce these islands, and effected a landing in 1710. But those who landed were never more heard of; and the ship from which they disembarked, after waiting long for them in vain, was at length compelled to depart, and to leave them on the island. Long. between 134. 5. and 134. 40. E. Lat. between 6. 54. and 8. 12. N.

PELIAS, in fabulous history, the twin-brother of Neleus, was son of Neptune by Tyro, daughter of Salmoneus. His birth was concealed by his mother, who wished her father to remain ignorant of her incontinence. He was exposed in the woods, but his life was preserved by shepherds; and he received the name of Pelias, from a spot of the colour of lead in his face. Some time afterwards Tyro married Cretheus, son of Æolus, king of Iolchos, and became mother of three children, of whom Æson was the eldest. Pelias visited his mother, and was received into her family; but after the death of Cretheus, he unjustly seized the kingdom, which belonged to the children of Tyro by the deceased king. In order to strengthen himself in his usurpation, Pelias consulted the oracle; and when he was told to beware of one of the descendants of Æolus, who should come to his court with the one foot shod and the other bare, he privately removed the son of Æson, after he had openly declared that he was dead. But these precautions proved vain. Jason, the son of Æson, who had been educated by Chiron, returned to Iolchos when come to years of maturity; and having lost one of his shoes in crossing the river Anaurus or Evenus, Pelias immediately perceived that this was the person whom he had so much dreaded. His unpopularity prevented him from acting with violence to a stranger, whose uncommon dress and commanding aspect had raised admiration in the people. But his astonishment was greatly excited when he saw Jason arrive at his palace, with his friends and relations, and boldly demand the kingdom which he had usurped. Pelias, conscious that Jason's complaints were well founded, endeavoured to divert his attention, and told him that he would voluntarily resign the crown to him, if he should proceed to Colchis in order to avenge the death of Phryxus, the son of Athamas, whom Æeres had cruelly murdered. He further declared, that the expedition would be attended with the greatest glory, and that nothing but the infirmities of old age could prevent himself from vindicating the honour of his country, and the injuries of his family, by punishing the assassin. This proposal, so warmly recommended, was with equal warmth accepted by the young hero, and his intended expedition was made known all over Greece. Whilst Jason was absent on the Argonautic expedition, Pelias murdered Æson and all his family; but, according to the more received opinion, Æson was still living when the Argonauts returned, and he was restored to the flower of youth by the magic of Medea. This change in the vigour and constitution of Æson astonished all the inhabitants of Iolchos; and the daughters of Pelias, who have received the patronymic of Peliades, expressed their desire to see their father's infirmities vanish by the same powerful magic. Medea, who wished to avenge the injuries which her husband Jason had received from Pelias, raised the desires of the Peliades, by cutting an old ram to pieces, boiling the flesh in a cauldron, and then turning it into a fine young lamb. Having witnessed this successful experiment, the Peliades cut their father's body to pieces, after they had drawn all the blood from his veins, on the assurance that Medea would replenish them by her wonderful power. The limbs were immediately put into a cauldron of boiling water; but Medea, suffering the flesh to be totally consumed, refused to give the promised assistance, and the bones of Pelias did not even receive the honours of sepulture. The Peliades were four in number, Alceste, Pisidice, Pelopea, and Hippothoe, to whom Hyginus adds Medusa. Their mother's name was Anaxibia, the daughter of Bias or Philomache, the daughter of Amphion. After this parricide, the Peliades fled to the court of Admetus, where Acastus, the son-in-law of Pelias, pursued them, and made their protector prisoner. The Peliades died and were buried in Arcadia.

PELICONDAH, a town of Hindustan, in the province of the Circars, and district of Cicacole. Long. 84. 10. E. Lat. 18. 33. N.

PELIME, a river of Asiatic Russia, which falls into the Taudo, near the town of the same name.

PELING, an island in the Yellow Sea, near the coast of Corea, ten miles in length and four in breadth. Long. 124. 28. E. Lat. 38. 24. N.

PELING *Isle*, an island in the Eastern Seas, near the east coast of the island of Celebes, between the 123d and 124th degrees of east longitude. It is fifty miles in length by fifteen in breadth, and is surrounded by many smaller isles, with numerous rocks and shoals. Long. 124. 28. E. Lat. 38. 24. N.

PELION, a mountain of Thessaly, near Ossa. It rises majestically over the Sinus Pelasgicus, having its top covered with pines, and its sides with oaks. From this mountain was cut the spear of Achilles, called *pelias*, which none but himself could wield.

PELLA, in *Ancient Geography*, a town situated on the confines of Emathia, a district of Macedonia. It was the royal residence, and being situated on an eminence verging to the south-west, was encompassed with impassable marshes summer and winter.

PELLETIER, BERTRAND, a celebrated chemical philosopher, was born at Bayonne in the year 1761. He very soon discovered a strong predilection for the sciences, to cherish which he had every thing in his father's house that could reasonably be desired, and there acquired the elements of that art for which he was afterwards so famous. His subsequent progress took place under Darcet, who admitted him amongst the pupils attached to the chemical laboratory of France. Five years of intense application under such a master gave him a stock of knowledge very uncommon at his years. As a convincing proof of this, when only twenty-one years of age, he published a number of valuable observations on arsenic acid; proving, contrary to the opinion of Macquer, that sulphuric acid distilled from the arseniate of potash disengages the acid of arsenic.

Encouraged by the success which had attended his first chemical labours, he communicated his remarks on the crystallization of sulphur, cinnabar, and the deliquescent salts; as also the examination of zeolites, particularly the false zeolite of Freyburg, which he discovered to be merely an ore of zinc. He likewise made observations on the oxygenated muriatic acid, in reference to the absorption of oxygen; on the formation of other acids, chiefly the muriatic and the acetous; and a number of memoirs on the operation of phosphorus made in the large way, its conversion into phosphoric acid, and its combination with sulphur and most metallic substances.

It was by his operations on phosphorus that he burned himself so severely as nearly to endanger his life. Immediately on his recovery he began the analysis of different varieties of plumbago from France, England, Germany, Spain, and America, and gave both novelty and interest to his work, even after the labours of Scheele on the same subject had made their appearance. The analysis of carbonate of barytes led him to make experiments upon animals, from which he discovered that this earth is a real poison, in whatever way it be administered. Strontites was also analysed by this celebrated chemist, and found to contain a new earth.

Pelletier discovered a process for preparing verditer in the large way, equal, it is said, in beauty to that which is manufactured in England. He was likewise amongst the first who showed the possibility of refining bell-metal, and separating the tin. His first experiments were performed at Paris, after which he went to the foundery at Romilly to prove their accuracy in the large way. He was soon after this admitted a member of the Academy of Sciences at Paris, and subsequently accompanied Borda and General Daboville to La Fère, to assist in experiments upon a new species of gunpowder. Being obliged to pass great part of the day in the open air during a cold and moist season, in order to render his experiments more decisive, his health, which was naturally delicate, became very much impaired. He partly recovered it, but again fell a victim to his thirst of knowledge; for he was at one time nearly destroyed by inspiring the oxygenated muriatic acid gas, which occasioned a convulsive asthma, that at times appeared to abate, but was found to be incurable. The assistance of art was insufficient to save him, and he died at Paris on the 21st of July 1797, of a pulmonary consumption, in the flower of his age, being only thirty-six.

PELLEW, SIR EDWARD'S GROUP, a cluster of islands on the north coast of New Holland, which occupy a space of thirty-four miles east and west, by twenty-two north and south, on the western coast of the Gulf of Carpentaria. These islands are far from being fertile, and when the surface is not bare rock, it consists of sand, with a greater or less proportion of vegetable soil. The larger islands are covered with trees, bushes, and grass. In the large islands traces of the kangaroo are to be seen, and turtle-tracks on the beaches. Their names are Vanderlin's Island, North-west, South-west, and Centre Islands. The latitude of Centre Island is 15. 39. S.

PELLISSON, or PELLISSON FONTANIER, PAUL, was the son of James Pellisson, counsellor at Castres. He was born at Beziers in 1624, and educated in the Protestant religion. He studied with success the Latin, Greek, French, Spanish, and Italian tongues, and applied himself to the perusal of the best authors in these languages; after which he studied with reputation the law at Castres. In 1652 he purchased the post of secretary to the king, and five years afterwards became first deputy to M. Fouquet. He suffered by the disgrace of that minister; and in 1661 was confined in the Bastille, whence he was not discharged till four years afterwards. During his confinement he applied himself to the study of controversy; and in 1670 he abjured the Protestant religion. Louis XIV. bestowed upon him an annual pension of two thousand crowns, and he likewise enjoyed several posts. In 1676 he received the abbey of Giment, and some years afterwards the priory of St Orens at Auch. He died in 1693. His principal works are, 1. The History of the French Academy; 2. Reflections on religious Disputes, in four vols. 12mo; 3. The History of Louis XIV.; and, 4. Historical Letters and Miscellanies, in three vols. 12mo.

PELOPIA, a festival observed by the Eleans in honour of Pelops. A ram was sacrificed on the occasion; but priests and people were both prohibited from partaking of it, on pain of excommunication from Jupiter's temple; the neck only being allotted to the officer who provided wood for the sacrifice. This officer was called Ξυλευς; and white poplar was the only wood made use of at this solemnity.

PELOPONNESUS, a large peninsula to the south of the continent of Greece. It was called the island of Pelops, though properly not an island, but a peninsula, ending in a point like the leaf of the plane-tree. Anciently called *Apia* and *Pelasgia*, this peninsula was second to no other country for nobleness, being situated between the Ægean and Ionian Seas, and resembling a plane-leaf, on account of its angular recesses or bays. It is now called the Morea.

PELOPS, in fabulous history, the son of Tantalus, king of Phrygia, went into Elis, where he married Hippodamia the daughter of Œnomaus, king of that country, and became so powerful, that all the territory which lies beyond the isthmus, and composes a considerable part of Greece, was called *Peloponnesus*, from his name Pelops, and the Greek word νησος, an island.

PELTA, a small, light, manageable buckler, used by the ancients, and also worn by the Amazons. The *pelta* is said by some to have resembled an ivy leaf in form; by others it is compared to the leaf of an Indian fig-tree, and by Serbius to the moon in her first quarter.

PELUSSIN, a town of France, in the department of the Loire, and arrondissement of St Etienne. It has some considerable manufactories of silk; and the neighbourhood is remarkable for the great quantity of chestnuts which are collected annually for exportation. It contains about 460 houses, with 3350 inhabitants.

PELUSIUM, in *Ancient Geography*, was a strong city of Egypt, without the Delta, distant twenty stadia from the sea, and situated amidst marshes, from which circumstance it derived its name. It was called the *key* or *inlet of Egypt*, because, if taken, the rest of Egypt lay quite open and exposed to an enemy.

PEMBA, a low, well-wooded, and extremely fertile island, fourteen leagues in length, near the eastern coast of Africa. It exports both corn and cattle to a considerable amount. Long. 41. E. Lat. 5. S.

PEMBERTON, a township of the parish of Wigan, in the hundred of West Derby, in the county of Lancaster, 198 miles from London. It has no market, and is chiefly inhabited by manufacturers. The population amounted in 1801 to 2309, in 1811 to 2934, in 1821 to 3679, and in 1831 to 4277.

PEMBROKE, the county-town of the shire of that name, in South Wales, situated on a branch of the fine haven of Milford. It is 250 miles from London, and ten from Haverford West. It is a very ancient town, and was once defended by strong walls and a powerful castle, the ruins of which still remain. It consists of one long street, rising up to the remains of the castle, which has an imposing aspect. There are two churches, St Mary's and St Michael's, the latter of which is of a remote age. The county assizes and elections are held here; and there is a tolerable market, which is held on Saturday, but little trade of any kind. In virtue of the municipal reform law passed in 1835, the town elects annually a corporation, consisting of a mayor, six aldermen, and eighteen councillors, with justices of the peace nominated by the crown; for which purpose it is divided into two wards. The population amounted in 1801 to 2595, in 1811 to 2525, in 1821 to 4925, and in 1831 to 6511.

PEMBROKESHIRE is a maritime county of South Wales. It forms a peninsula at the south-west corner of the principality, and is surrounded by the sea everywhere except on the eastern side, where it is bounded by Carmarthenshire and by Cardiganshire. Its shape is very irregular, which makes it difficult to ascertain its exact extent. Its extreme length is thirty, and its extreme breadth twenty-seven miles. Its area is estimated, but with no decided accuracy, at 575 square miles.

It is generally an undulating county, composed of plains, with hills of no great elevation, except in the northern part, where a range of mountains is stretched out to the extent of nine or ten miles. The loftiest points of this group are Precelly Top, 1754 feet, and Brennin-Vaur, 1285 feet above the level of the sea. Few of the hills in the other parts of the county attain a greater height than 290 feet. As the greater part of the country is destitute of woods, it has a bare and bleak appearance, except in the valleys, where the numerous brooks which flow through them impart a pleasing verdure to the bordering meadows.

The most considerable rivers are the Eastern Cleddaus, which forms at first the dividing line between this county and Carmarthenshire; and the Western Cleddaus, which traverses a considerable portion of Pembrokeshire. These two rivers unite, and form the admirable estuary of Milford Haven, which is considered as the best harbour in the British islands. It is sufficiently capacious to contain the whole navy of England, is so completely sheltered as to be secure from all winds, and has good holding ground, with competent depth of water. During the war these advantages induced the lords of the admiralty to establish a dock-yard, chiefly with the view of building ships. It is situated on the southern shore of Milford Haven, about two miles from the town of Pembroke. It includes an area of about sixty acres, its surface descending in a gradual slope to the water's edge, along the shore of which there is ample space for a couple of dry docks, and at least twelve building slips. The work has been executed with care and accuracy; but, owing to the state of general tranquillity which has prevailed for more than twenty years, it is not of the vast importance that it may become in case of another extended naval war. When at its greatest height, this establishment had about five hundred men. The town of Huberstone, on this bay, is now the resort of the packet for the south of Ireland, and is thus a place of much activity, as far as regards the number of passengers to and fro. The entrance to this important estuary is almost free from danger; the principal difficulty is a sunken rock called the Chapel Rock, but it may easily be avoided, and has at low tide seventeen feet of water on it. This rock, as well as the shoals near it, is well buoyed. There are several bays on this coast, in which are good anchorage and safe riding for ships. The most important of these are St Bride's Bay, Ramsey Sound, and Nayland Road.

The rivers of this county are but of short course, and, with the exception of those two which empty themselves into Milford Haven, discharge but little water. The names of these rivers are the Newgall, the Solva, the Alan, the Gwayn, the Nevern, the Cuch, and the Tivy.

The soil of the county is generally a red loam, in many parts resting on a calcareous subsoil, and admirably adapted for the growth of corn. In some places the surface is covered with porous stones, which are supposed to imbibe and retain the salt from the saline air, and to render the land highly prolific. The principal grain consists of wheat, barley, and oats; but in some parts of the county rye is extensively cultivated. The modes of cultivation are commonly the same as those which prevailed in remote ages, that is, growing wheat, barley, and oats in succession, till the land was so exhausted as to yield no increase, when it was suffered to return to its natural state, under the idea of recovering itself by rest. Very little attention is paid to the preservation of manure; the barns and farming erections are very badly constructed; and the agricultural implements, especially the ploughs, are of a rude and antique form. Such is the description of the greater part of the agricultural state of the country; but there are splendid exceptions. The size of the farms varies from fifty to a hundred acres; but the average extent of them is estimated to be about two hundred. Some of the occupiers are annual tenants, but many hold from the lords of manors by leases for three lives at an agreed rent, though without any fine on the renewal of a life, as is customary in England, and on the lands in Pembrokeshire belonging to the church.

The black cattle of this county are of an excellent race, and are annually distributed over the south of England in droves, which travel from fair to fair till the whole are sold. They are commonly sent to market when they are in calf for the first time. Some valuable horses are bred here. The sheep are small, and yield little wool, but the mutton is very highly esteemed.

At no very remote period silver was found in the parish of St Elwys, or St Bride's Bay. The mine, which was discontinued in the reign of Queen Elizabeth, was resumed some years ago, but not with such success as to induce perseverance. Some excellent lead ore is found upon the banks of the Tivy, but the mines are not worked with any degree of spirit. The most important production of the mines is coal. It is confined to a district of narrow extent on the southern side of the county. The strata lie near the surface, and the quality is not very good. The inhabitants use the small coal mixed with clay and formed into balls; it is sulphureous, and highly offensive to strangers.

The manufactures of this county are exceedingly few, but the building of ships and boats gives employment to about 400 persons. There are about 130 weavers of woollen cloth and flannels; but they are so much scattered about the county, that the largest number in any one place is no more than seventeen at St David's. Attempts have been made to introduce cotton-spinning, but without success. The chief trade now consists in the conveyance of coals from Tenby to the opposite shore of Devon, Cornwall, and Somerset, where they are found fitter for lime-burners and maltsters than for fuel in dwellings. The great travelling causes the circulation of much money, and some is derived from the company that in the summer frequent Tenby for the purpose of sea-bathing.

The inhabitants are of two distinct races. If a line be drawn through the whole county, bisecting the town of Haverford West, it will be found that on one side of the line nothing but English is spoken, and on the other side only Welsh. This is so definite, that in the town of Haverford West the one language is spoken in the upper, and the other in the lower part of it; and there are two markets, one frequented by the English, the other by the Welsh peasantry. The part where the English live, commonly called Little England beyond Wales, was originally peopled by a colony of Flemings, who have kept themselves distinct since the first colonization. It is admitted that they speak the English language with more purity than the lower classes in any other part of the island.

One member of parliament is chosen by the freeholders for the county, and the polling-places are Haverford West, Pembroke, Narberth, Fishguard, Newport, Tenby, and Mathry. The towns of Milford, Pembroke, Tenby, and the ancient borough of Wiston, elect one member amongst them.

St David's, the see of a bishop, is a miserable collection of cottages, in the midst of traces of ancient, extensive, and numerous buildings. The object deserving of most notice is the cathedral, the antiquity of which is very great, having been originally built about the year 1180, and enlarged in 1280 and 1328. The bishop's palace is a magnificent pile, not far from the cathedral, on the opposite side of the river Alan. It was originally a quadrangular building of great extent, of which at present only one side remains entire.

Amongst the ancient buildings in this county, the most remarkable are Carew Castle, on a creek of Milford Haven; Manorbeer, the mansion of the Barry family, of which Giraldus Cambrensis was a member; and Killgarran, on the river Tivy, the massy towers and fragmented bastions of which present a most imposing spectacle.

The picturesque beauties of this county, the mildness of the air, and the abundance of every thing, have induced many gentlemen to select it as the place of their residence. The houses of this description are therefore too numerous to be mentioned; but amongst the more ancient proprietors who have splendid seats are, Lord Milford, Sir John Owen, Lord Kensington, Lord Cawdor, and several others.

The population of the county amounted in 1801 to 56,280, in 1811 to 60,615, in 1821 to 74,009, and in 1831 to 80,900. The annual value of the real property, as assessed in 1815 for the property tax, was L.219,589.

According to the returns of the year 1831, the families chiefly employed in agriculture were 7974; those chiefly employed in trade, manufactures, and handicraft, were 4510; and those comprised in neither of the preceding classes were 4102. The number of males under twenty years of age was 18,356. The occupiers employing labourers were 1842, and the occupiers not employing labourers were 1864. The labourers employed in agriculture were 6075. Persons employed in manufactures or manufacturing machinery were 131; those employed in retail trade, or in handicraft, or masters, or as workmen, 4785; capitalists, bankers, professional and other educated men, 605; labourers employed in labour not agricultural, 1599; other males under twenty years of age (except servants), 1124; male servants, twenty years of age, 331; male servants under twenty years of age, 219; female servants under twenty years of age, 4929. The towns and their population which exceed 2000 persons are, Pembroke, 6511; Haverford West, 3915; Narberth, 2589; St David's (city), 2388; Tenby, 2128; and Dogmels, 2109.

PEMGUR, a town of Hindustan, in the province of Khandeish, belonging to the Mahrattas, on the southern bank of the Nerbuddah, seventy-three miles south-east from Oojain. Long. 76. 35. E. Lat. 22. 28. N.

PEMNAGUR, a town of Hindustan, in the province of Bahar, and district of Tirhoot. It formerly possessed a strong fort, surrounded by a thick wood. Long. 85. 43. E. Lat. 26. 29. N.

PEN, a little instrument, usually formed of a quill, and serving to write withal. But pens are sometimes made of silver, brass, or iron.

Dutch Pens are made of quills which have passed through hot ashes, to take off the grosser fat and moisture, and render them more transparent.

Fountain Pen is a pen of silver, brass, or other metal, so contrived as to contain a considerable quantity of ink, and let it flow out by degrees, to supply the writer a long time without his being under the necessity of taking fresh ink.

The *Geometric Pen* is an instrument by which a right line, a circle, an ellipse, and other mathematical figures, may be described by a circular motion. It was first invented and explained by Suardi, in a work entitled *Nuovo Instromento per la Descrizzione di diverse Curve antiche e moderne.* Several writers had observed the curves arising from the compound motion of two circles, one moving round the other; but Suardi first realized the principle, and reduced it to practice.

PENAFIEL, a town of the province of Toro, in Spain, the capital of a partida of the same name. It is situated on the river Duraton, and has a citadel, four churches, two monasteries, and 650 houses, with 3400 inhabitants.

PENANCE, a punishment, either voluntary or imposed by authority, for the faults which a person has committed. Penance is one of the seven sacraments of the Catholic church. Besides fasting, alms, abstinence, and the like, which are the general conditions of penance, there are others of a more particular kind; as the repeating a certain number of ave-marias, pater-nosters, and credos, wearing a hair-shirt, and giving one's self a certain number of stripes.

PENARANDA, a town of Spain, in the province of Avela, and partida of St Jago. It is the capital of a small district called the Sermo de St Vincente. It was once fortified, but its walls are now in a dilapidated state. It has a fortress, three churches, two monasteries, nine hundred and fifty houses, and about 3500 inhabitants, depending for a scanty subsistence chiefly on the cultivation of the soil.

PENATES, in Roman antiquity, were a kind of tutelar deities, either of countries or particular houses, in which last sense they differed in nothing from the lares. The penates were properly the tutelar gods of the Trojans, and were only adopted by the Romans, who gave them the title by which they are here described.

PENCIL, an instrument used by painters for laying on their colours. Pencils are of various kinds, and made of various materials. The largest sorts are made of boars' bristles, the thick ends of which are bound to a stick, larger or smaller, according to the uses they are designed for. The finer sorts of pencils are made of camels', badgers', and squirrels' hair, and of the down of swans, which are tied at the upper end with a piece of strong thread, and enclosed in the barrel of a quill.

Pencil is also an instrument used in drawing or writing. It is made of long pieces of black lead or red chalk, placed in a groove cut in a slip of cedar; upon which other pieces of cedar being glued, the whole is planed round, and one of the ends being cut to a point, it is fit for use.

PENDANT, an ornament hanging at the ear, and frequently composed of diamonds, pearls, or other jewels.

Pendants, in *Heraldry*, parts hanging down from the label to the number of three, four, five, or six at most, resembling the drops in the Doric frize. When they are more than three, they must be specified in blazoning.

Pendants of a Ship are those streamers, or long colours, which are split and divided into two parts, ending in points, and suspended at the heads of masts, or at the yard-arm ends.

PENDLETON, a township in the parish of Eccles and hundred of Salford, in the county of Lancaster, a hundred and eighty-eight miles from London and three from Manchester. It has no market, and is chiefly inhabited by manufacturers of cotton goods. The population amounted in 1801 to 3611, in 1811 to 4805, in 1821 to 5948, and in 1831 to 8435.

PENDULUM.

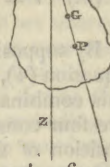
Pendulum.

When a solid and heavy body of any form and description is suspended from an axis fixed horizontally, and round which it can turn with freedom, or at least with a very slight degree of friction; if we withdraw it, however little, from the position of equilibrium at which it naturally places itself when at rest, and then abandon it to itself, the force of gravity, which is now no more destroyed by the resistance of the axis of suspension, brings back the body towards its primitive position of equilibrium with a velocity continually accelerated. When it reaches this position, the accelerating force ceases for a moment to act on it, but the body, continuing to move in consequence of the velocity already acquired, rises on the other side of the vertical line, and continues rising until the constantly increasing force of gravity destroys its velocity—then it stops for an instant, and again yielding to the continued action of gravity, to which there is now no more opposition, it again falls with a motion exactly similar to that which it had when it began to descend from the opposite side of the vertical. It returns then, in the same manner, to its primitive position of equilibrium, passes it, and re-ascends on the opposite side of the vertical, to the point where its velocity is destroyed anew; after which it again begins to descend, and again to remount; and the oscillatory motion which results from these alternations only ceases in consequence of the resistance of the air and the friction of the axis, which gradually reduce it to nothing.

An apparatus of this kind is termed a *pendulum.* The oscillations of pendulums can be calculated completely, and with perfect rigour, by the principles of mechanics, when they are supposed to take place in a vacuum, and round an axis, which presents no friction. The results in regard to this imaginary case are so much the more important to be known, as in the real experiments we always endeavour to approach it as near as possible, by combining to the utmost every circumstance which can tend to prolong the duration of the pendulum's motion. These are the results, then, which it is proper to present first in order, as they exhibit a first approximation to every motion of this kind which can be realized.

In this simple case, whatever be the form of the body which constitutes the pendulum, provided that it remains invariably constant, all the successive oscillations have equal amplitudes, and are also of equal duration among themselves, so that the motion, once begun, never ceases to go on. In the case of oscillations with different amplitudes, the duration is in general unequal; but this inequality diminishes in proportion as the amplitudes become less, and it ceases altogether at the limit where they become infinitely small; so that all the oscillations made with amplitudes, which, in a physical sense, may be reckoned infinitely small, are sensibly of equal duration.

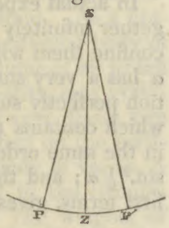
Fig. 1.



In regard to the nature of the motion in each oscillation, it is absolutely the same for every body, whatever be its form; and we may always consider it as identical with that of a pendulum formed by a material gravitating point suspended at the extremity of a thread, supposed to be inflexible and without weight. Let l denote the ideal length of such a pendulum, which is called a *simple pendulum.* Let m be the mass of an oscillating body (fig. 1) with which we wish to compare it, and which we shall call, in opposition to the other, a *compound pendulum.* From the centre of gravity of this body, denoted by G, conceive a perpendicular SG drawn to the axis of suspension, and call h the length of this line. If we multiply each element of the mass m by the square of its distance from the same axis, and denote the sum of the whole by c, the product c thus formed will be what is called in mechanics the momentum of inertia of the body m relatively to the axis in question. In order that the motion of the simple pendulum SP be exactly isochronous with that of the body m, it is sufficient that we have the equation $l = \frac{c}{mh}$; and, besides this, that the lines SP and SG have at any one instant equal angular velocities at the same distance from the vertical. This last condition will be fulfilled if, for example, at the beginning of the motion the lines SP, SG are equally distant from the vertical, and that the simple and compound pendulum be then abandoned together to the action of gravity, or be driven with equal velocities in the plane of their oscillations. The simple pendulum will then accompany the compound one in all its successive excursions, and its direction will always coincide with the line SG drawn from the centre of gravity of the body m, perpendicular to the axis of suspension. The length l being ascertained by this formula, we can lay it off on the line SG, setting out from the axis of suspension S; and the point P, where it terminates, is called the *centre of oscillation* of the body m.

The initial conditions above stated can always be established, and the analytical value of l is also always real. For every given compound pendulum, then, we can always assign a simple pendulum, which is isochronous with it, and of which the motion is absolutely similar to that of the line SG. By means of this substitution, we have nothing more to consider or to compare, but the different lengths of the simple pendulums, and it then only remains to ascertain the mode in which such pendulums perform their oscillations.

Fig. 2.



To do this in the simplest manner possible, let us conceive that the arc ZP (fig. 2) is half the extent of the oscillations through the vertical SZ, and suppose that the pendulum arrived or placed in this position is there abandoned to the sole action of gravity without any initial velocity of impulsion. Call α the angle PSZ, and denote by g the intensity of gravity measured by the double of the space which heavy bodies describe at the place where the experiment is made, when they fall freely in a right line during the unity of time. Then denoting always by l the length of a simple pendulum SP or SZ, the time T of its whole oscillation in the arc PZP′ or PP′ will be expressed by the following series:

$$(1.)\ \mathrm{T} = \pi\sqrt{\frac{l}{g}}\left\{1 + \left(\tfrac{1}{2}\right)^2 \sin.^2 \tfrac{1}{2}\alpha + \left(\frac{1\cdot3}{2\cdot4}\right)^2 \sin.^4 \tfrac{1}{2}\alpha + \left(\frac{1\cdot3\cdot5}{2\cdot4\cdot6}\right)^2 \sin.^6 \tfrac{1}{2}\alpha +, \&c.\right\},$$

π being the ratio of the circumference of the circle to its diameter, or 3·14159.

If, besides, we denote the velocity of the pendulum in any point of its oscillation by V, θ being its angular distance from the vertical, we have

$$(2.)\ \mathrm{V}^2 = 2gl(\cos.\theta - \cos.\alpha),$$

or, what comes to the same thing,

$$\mathrm{V}^2 = 4gl \sin.\tfrac{1}{2}(\alpha + \theta) \sin.\tfrac{1}{2}(\alpha - \theta).$$

These formulæ will still serve if the pendulum, instead of falling freely from the extremity of the arc, receives there an initial velocity expressed by V′, provided always this velocity is within the limits which permit the oscillatory motion to take place. If this be the case, indeed, it will be sufficient to consider the pendulum as setting out with an initial impulse from another angular distance, α'. Then it will be necessary that this unknown distance α' satisfy, instead of α, the general equation of the velocities, and that α becomes in it θ, which gives

$$(3.)\ V'^2 = 2gl\{\cos.\alpha - \cos.\alpha\}.$$

The half amplitude α' of the oscillations being the only unknown quantity in this equation, will be thus determined, and their duration will be then obtained by the equation (1), but putting in it α' instead of α. This same substitution made in the equation (2) will give

$$V^2 = 2gl(\cos.\theta - \cos.\alpha')$$

for the velocity in any point whatever of the oscillation. But these transformations are only possible when the equation (3) gives for α' a real arc, and consequently for cos. α' a value comprehended between + 1 and — 1. We may easily conceive, that, when the cos. α' exceeds these limits, it is because the velocity of impulse V′ exceeds the greatest velocity of the fall which the pendulum can acquire in a circle of a radius l, even supposing it to fall from the very summit. It is evident indeed that the oscillatory motion can then no more produce such a velocity, and we know also that, in that case, it will change into a continued motion of rotation. If we exclude this circumstance, the formulæ (1) and (2) will determine generally every particular regarding oscillatory motions. When the amplitudes of the oscillations become so small that we can, in the series (1), neglect all the powers of $\sin.^2 \frac{1}{2}\alpha$, compared with the unity which precedes them, we will have simply

$$T = \pi\sqrt{\frac{l}{g}}.$$

Now, the angle α entering no more into the value of T, it appears that its value will have no influence on it; that is to say, that *for the same pendulum moved in a vacuum, all the oscillations which are performed with amplitudes infinitely small, are of equal durations.*

In actual experiment, the oscillations can never be altogether infinitely small, but we may take care, at least, to confine them within amplitudes so limited that the angle α has a very small value. We have then an approximation perfectly sufficient in limiting the series to the term which contains the square of the sin. $\frac{1}{2}\alpha$. We may then, in the same order of approximation, substitute $\frac{1}{4}\sin.^2\alpha$ for $\sin.^2\frac{1}{2}\alpha$; and the series (1), being thus limited to its two first terms, gives

$$T = \pi\sqrt{\frac{l}{g}}\left\{1 + \frac{1}{16}\sin.^2\alpha\right\},$$

α being always the half amplitude of the oscillation.

We have seen above, that, by supposing the simple pendulum l isochronous with the compound pendulum of the mass m, we have

$$l = \frac{c}{mh},$$

c being the momentum of inertia of the mass m, relatively to the axis of suspension. But if we call c' the momentum of the same mass, relatively to an axis parallel to the preceding, and passing through the centre of gravity G, we find, by mechanics, that the quantities c, c' have between them the following relation :

$$c = mh^2 + c'.$$

This value of c, being substituted in the expression of l, gives evidently

$$l = h + \frac{c'}{mh}.$$

Now, when h is given, this expression only furnishes one value of l; that is to say, a single length for a simple pendulum isochronous with the mass m. But if l be given, then there are two values of h which give the same value to l; and these are deducible from the preceding equation, by taking h in it as the unknown quantity. If we denote these two values of h by h' and h'', it is easy to see that their sum is l, and that thus the first being SG (fig. 1), the second will be PG. If, then, after having placed the axis of suspension in S, we place it in P, that is, in the centre of oscillation itself, preserving it always parallel to its first direction, the oscillations performed round the axis P will be of the same duration as those performed round the axis S, provided always that in both cases the amplitudes of the oscillation, as well as the initial velocities, are equal. This remarkable theorem we owe to Huygens.

It is easy to extend it to one much more general. In all solid bodies, whatever be their figure, we may draw through the centre of gravity three rectangular axes, termed in mechanics *principal axes*, and which possess several properties extremely remarkable. Let the momentum of inertia of the mass m relatively to these axes be denoted by A, B, C. Then, if we consider any axis of suspension of which the distance from the centre of gravity is expressed as above by h, and which forms with the preceding certain angles, X, Y, Z ; it is shown, in mechanics, that the momentum of inertia c'', relative to this axis, can be expressed in the following manner :

$$c'' = mh^2 + A\cos.^2 X + B\cos.^2 Y + C\cos.^2 Z\,;$$

and this value being substituted in l, instead of the letter c, gives

$$l = h + \frac{A\cos.^2 X + B\cos.^2 Y + C\cos.^2 Z}{mh}.$$

If, now, the axis of suspension be given along with the distance h, this expression gives but a single value for l; but if we regard l as given, and constant, then there arises between the angles X, Y, Z, and the distance h, a simple relation, which we can satisfy in an infinity of different ways, so that there result as many different axes of suspension, which are all isochronous with each other. To be sensible of the extensive application of such solutions, let us transform the preceding relation into one with rectilineal co-ordinates. Let x, y, and z, be such co-ordinates directed rectangularly, according to the three principal axes of the mass m, and having their common origin at the centre of gravity of this mass, the axis of suspension relatively to these co-ordinates will have its equations of the form

$$(4.)\quad x = az + \alpha \qquad y = bz + \beta,$$

a, b, α, β, being four constant indeterminate quantities, depending on their position in space. We have, besides, by the well-known theorems of analytical geometry,

$$\cos. X = \frac{a}{\sqrt{1 + a^2 + b^2}},\ \cos. Y = \frac{b}{\sqrt{1 + a^2 + b^2}},$$

$$\cos. Z = \frac{1}{\sqrt{1 + a^2 + b^2}},\ \text{and, lastly,}\ h = \frac{\sqrt{\alpha^2 + \beta^2}}{\sqrt{1 + a^2 + b^2}}.$$

By substituting these values in the general expression of l, it becomes

$$(5.)\quad l = \frac{\sqrt{\alpha^2 + \beta^2}}{\sqrt{1 + a^2 + b^2}} + \frac{Aa^2 + Bb^2 + C}{m\sqrt{\alpha^2 + \beta^2}\sqrt{1 + a^2 + b^2}}.$$

By supposing l constant, this relation, combined with the equation (4), will characterize the isochronous axes : but as this combination only furnishes three equations, while there are four constant indeterminate quantities a, b, α, β, in the position of the axis, it hence appears that we may still assume at pleasure an additional condition among the quantities themselves, after which, by eliminating them, we shall have, in *xyz*, the equation of a surface on which will be found the isochronous axes fitted to satisfy the condition prescribed.

Having thus made known the laws of oscillatory motion in a vacuum and round an axis altogether free from friction, let us now consider them in a feebly resisting medium like air, and supposing a slight degree of friction round the axis, such as is invariably the case in the experiments.

In the first place, whatever be the nature of the physical process by which the two causes operate, their definite effect will always be to retard the pendulum, according to a certain function of the velocity. But whatever be the form of this function, provided it be such as to become nothing when the velocity is nothing, which is an essential condition of the kind of obstacles it is designed to express, we may always assign a simple pendulum which, moving with the same laws of friction and resistance, will be exactly isochronous with the compound pendulum we are considering; and, what is very remarkable, the length of this simple pendulum is exactly the same as it would be if the oscillations were performed in a vacuum, and consequently the same as that of which we have given the expression above. Thus the centre of oscillation of solid bodies, such as we have defined it, has in each of them a situation independent of the medium in which they move, and of the resistances of every kind which their motions may suffer. This important proposition was first demonstrated by Clairault.

Now, for the simple pendulum, as well as for the compound one which accompanies it, the resistance of the air and the friction of the axis diminish continually the extent of the arcs in which the successive oscillations are performed; but it happens, from a circumstance well worthy of remark, that when this retarding force is very slight, and acts with continued and equal effect on both sides of the vertical, the durations of the oscillations are not altered on this account. For, although the resistance which the pendulum suffers must retard, no doubt, its fall, and consequently prolong its duration in each half oscillation in descending; yet in each half oscillation in ascending, this same cause accelerates the extinction of the velocity, and rather brings on the instant when this half oscillation is terminated. And whatever be the mathematical law of the motion thus performed, if the amplitudes of the successive oscillations diminish very slowly, which always takes place when the body put into oscillation has a very considerable density relative to that of the air, and if we make it perform vibrations only of very small extent, and round an axis of suspension so worked as to present but a slight degree of friction, then the motion of the pendulum presents a succession of velocities almost exactly similar in each descending half oscillation, and in the ascending half which follows it. The alterations produced in these velocities by the friction and the resistance of the air are then almost equal, so that their effects are almost exactly compensated in the actual observations. Hence it follows that the isochronism of small oscillations, though altered in each particular half oscillation, is still found to subsist in the total oscillations, notwithstanding of the friction of the axis and the resistance of the air, provided always that these two forces are rendered so feeble as to have but a very gradual influence on the motion. This is at least proved by experiment; for, when a compound pendulum of any form whatever oscillates in the air round a suspension, so free that the decrease of its vibrations goes on with great slowness, if we observe the amplitudes of these vibrations at intervals so near each other that their absolute diminution is inconsiderable, and apply to the number of oscillations performed during this interval the reduction of amplitude calculated according to the mean value of the arcs thus observed; the number of oscillations corrected and reduced in this manner to the case of amplitudes infinitely small, is also found invariably the same for the same pendulum, at least with all the degree of exactness admitted by physical experiments; which shows that the correction of the amplitude is the only one which the oscillations require in order to reduce the motion of the pendulum to a uniformity quite mathematical. This spontaneous compensation, which is produced in the effects of the resistance of the air on the two descending and ascending half oscillations, had first been remarked and pointed out by Newton in his *Principia*, lib. ii. prop. xxvii. theor. xxii. coroll. 2. He even gives a rigorous demonstration of it in prop. xxvi. and xxvii. for the case of a resistance proportional to the two first powers of the velocity —the motion being then in the cycloid. M. Poisson has given the analogous demonstration for a circular motion in the seventh volume of the *Journal de l'Ecole Polytechnique*. These demonstrations, however, only apply to that part of the resistance which arises from the direct impulse with which the moving body strikes the aërial particles, supposing these particles quite removed after the stroke, and consequently without regard to the peculiar agitation which their displacement produces in the medium itself. But, as Newton remarks in the corollary above cited, the descending half oscillation, which is performed with a motion continually accelerated, must, on this account, excite a resistance in a slight degree stronger than the half oscillation ascending, which goes on with a motion continually retarded; because, in this second case, the aërial particles struck by the pendulum may fly from it, and withdraw themselves from its action more easily than in the former. This diminution of the resistance in the second half of the oscillation must cause it to last a little longer than it would have done without this circumstance, and thus the time of the whole oscillation must be a little augmented. Fortunately this cause, it appears, becomes insensible in the most important experiments to which the pendulum is applied; for in these the observations are never made but with very small amplitudes, which produce very small velocities, and these cannot excite any sensible resistance except by the direct impulse communicated to the ambient medium.

But, independently of its resistance, the air, by its mere presence, floating round the oscillating body, produces on the motion another effect, which may be called *statical*, and which must be attended to, in order to compare the observations made in different states of this fluid. As a gravitating medium, in fact, it deprives the oscillating body of a part of its weight equal to that of the volume of air which the body displaces, so that the latter, in reality, only gravitates in consequence of the difference between these two quantities. To calculate the resulting effect on the oscillations, call P the absolute weight of the body in vacuo, Δ its density, compared with that of the air in the circumstances under which we are operating. The weights of bodies of equal volume being proportional to their densities, the weight of the air displaced by the body will be $P \cdot \frac{1}{\Delta}$; thus the apparent weight of this same body, during its oscillations, will be $P - \frac{P}{\Delta}$, so that it will be to its absolute weight as $1 - \frac{1}{\Delta}$ to 1. The effect, then, will be the same as if the absolute weight P were acted on, not by the actual gravity itself, but by a force diminished in this ratio. We have only, therefore, to reduce the elements of this correction to terms that we can compare together. For this purpose, suppose that at the temperature of freezing, and under an atmospheric pressure measured by a column of mercury of 0·76 metre in height, D represents the density of the substance of the pendulum, that of the air being taken as unity. If we denote the cubic dilatation of this substance for a change of temperature equal to a centesimal degree, by c, its density at t degrees will become very nearly $D\,(1-c\,t)$; and if p is the atmospheric pressure at this temperature, the corresponding density of the air, according to the known law of the dilatation of this fluid, will be

$$\frac{p}{0^{m}\cdot 76(1\cdot + t\cdot 0\cdot 00375)}.$$

Then denoting the absolute intensity of gravity, as it is exerted on the body in vacuo, by g, and the apparent force with which it really moves the body in the air by g', we shall have

$$g' = g\left\{1 - \frac{p}{0^{m}\cdot 76(1+t\cdot 0\cdot 00375)(1-c\,t)D}\right\}.$$

To illustrate the use of this correction, let l' represent the length of a simple pendulum, which performs its oscillations in the time T', under the influence of the apparent gravity g', and with the amplitude $2\alpha'$, we shall have

$$T' = \pi\sqrt{\frac{l'}{g'}}\left\{1 + (\tfrac{1}{2})^2 \sin.^2 \tfrac{1}{2}\alpha' +, \&c.\right\}.$$

In the same manner, if we call l the length of a simple pendulum, which makes its oscillations in the time T, under the influence of gravity g, and with the amplitude 2α, we shall have

$$T = \pi\sqrt{\frac{l}{g}}\left\{1 + (\tfrac{1}{2})^2 \sin.^2 \alpha +, \&c.\right\}.$$

If onw we wish the two pendulums to oscillate with equal amplitudes, we have only to make $\alpha = \alpha'$; if we wish, also, to have their times of oscillation equal, we have only further to suppose $T' = T$, then the two preceding expressions being equal to each other, we obtain $\frac{l}{g} = \frac{l'}{g'}$ and $l = l'\frac{g}{g'}$, from which we can calculate l, when we know from observation l' and $\frac{g}{g'}$.

As the density of the solid mass of the pendulum is usually very great, compared with that of the air, D is a very considerable number, so that this correction is always very small. Bouguer appears to have been the first philosopher who made use of it, as appears by his work on the figure of the earth. But before him Newton was well aware of the necessity of paying attention to it, as we may conclude even from the enunciation which he gives to the propositions regarding the resistance of the air above alluded to. For he there compares the motion of the pendulum, affected by this resistance, to that which would take place in *a medium of the same specific gravity, and which would present no resistance.*

Having thus explained in general the mathematical laws of the motion of the pendulum, whether in the air or in vacuo, we shall now describe the principal applications which have been made of them in physical science. These are, 1*st*, the measurement of time; 2*d*, the estimating of the resistance of fluid media; 3*d*, the comparison of the intensities of gravity on different parts of the surface of the terrestrial spheroid, from which certain positive conclusions have been drawn regarding the figure of a spheroid, as well as the arrangement and the density of the strata of which it is formed.

The first idea of employing the pendulum as a measure of time is due to Galileo; and it occurred to him when he was observing the apparent isochronism of the small oscillations of suspended bodies. But the variation in the length of these oscillations, in proportion as the resistance of the air diminishes their amplitude; the necessity of frequently renewing, by a new impulse, the motion which this resistance was destroying; and, lastly, the tedious necessity of following, and counting directly, the oscillations, one by one, during the whole interval that is to be measured; these proved serious obstacles to a practical and certain use of the instrument. Huygens had the merit of surmounting all these difficulties, by employing the pendulum in clocks to regulate the motions of a system of wheels, acted on by a constant power which tends continually to make them revolve; the pendulum determining the rate of their gradual rotation, by acting on them at equidistant intervals. The pendulum carries at its upper extremity a piece in the form of an anchor, which is termed the escapement, and of which the two ends, carried successively from right to left, and from left to right, by the oscillatory motion, are alternately engaged and disengaged with the teeth of a principal wheel, whose rotation they thus serve to check, and which, in its turn, serves as a similar alternate check to the other wheels. These now turn more or less slowly, according to the relation of the number of their teeth to that of the principal wheel. By applying, then, to their axes one or more indices, which turn on a dial-plate divided on the outside, we obtain by their indications so many unities of different kinds, the amount of which shows the number of oscillations that have been made. These unities of time are *hours, minutes,* and *seconds.* Great care is taken in the construction as well as in the application of the wheels, so that their motion may be as easy as possible, and that they may always obey, with equal facility, the intermitting impressions of the pendulum. The body of the pendulum itself is constructed with particular precautions. It is formed of a rod, or system of rods, of metal, terminated below by a mass also of metal, and very heavy; generally of a lenticular form, which, as the edge lies in the direction of the plane of oscillation, possesses the advantage of diminishing the effect of the air's resistance. Besides this, as the dilatations and contractions of the metal, by the changes of temperature, would lengthen or contract the pendulum, and thus cause it to alter the duration of its oscillations, the stalk of the pendulum is composed of a number of slips of different metals, which are so combined that the centre of oscillation of these slips and of the lenticular weight remains constantly at the same height.

Such is, in general, the mode of applying the pendulum to clocks, which we owe to Huygens, and which, by the exactness it has introduced in the measurement of time, is one of the finest and most valuable presents which the sciences have ever received from the hands of genius.

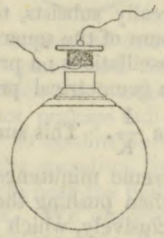
The second application of the pendulum, namely, its use in determining the resistance of fluid media, we owe to Newton, who has explained it with much detail in the sixth section of the first book of the *Principia.* The intensity, and the law of the resistance, are estimated from the progressive diminution of the amplitudes, determined by observation. We may see in that part of the work above referred to, the profound nature of the theory on which this deduction is founded, as well as the experiments themselves to which Newton applies it. The pendulums which Newton made use of were, in general, spheres of wood, or of metal suspended by threads. Besides the law, also, of resistances, several important points in physics depend on this sort of observation. Newton, for example, made use of it to establish the fact, that the action of terrestrial gravity upon all bodies is proportional to their mass; and also to inquire if these bodies, when in motion, suffer any sensible resistance by the presence within them of subtile media, which have been supposed to spread throughout the whole universe.

Lastly, it now remains to consider the use of the pendulum in measuring the intensity of gravity on different parts of the terrestrial spheroid; and we have kept this application for the last, on account of the delicate nature of the experiments which it requires, and which are now really performed. It would be of no use to enumerate here all the methods which have been successively employed, and successively abandoned as experiments of greater exactness came to be required. Even the results of these first attempts, though they may have been at the time very useful, cannot now be any more employed, so much do the limits of the errors which they admitted of exceed those which are allowed by our actual processes. These can be reduced to three principal methods; two of them give the absolute measure of the pendulum; the one is due to Borda, the other to Captain H. Kater; the third gives merely the relations of the lengths of pendulums in different places, and deduces these by comparing the number of oscillations performed in the same interval of time by the same compound pendulum, supposed to be of an invariable form, and which is carried successively to the different places of observation.

I.—BORDA'S METHOD.

The method used by Borda was originally described in a memoir inserted in the third volume of the work which Delambre has published under the name of *Base du Système Metrique Decimal.* The same memoir includes a detailed account of a very great number of experiments performed in this manner by Messrs Borda and Cassini, to determine the length of the seconds pendulum at the observatory at Paris. The method of Borda has since been simplified by the French astronomers, so that, without losing any of its original exactness, it has been rendered more easy of execution in travelling, and in places where the observer can only reckon upon the resources he carries with him. Under this new form this method has been employed on a great number of points of the terrestrial arc, comprehended between the Pithiuse Islands and the Shetland Islands. The description of these modifications, and of the results thus obtained, will be found in a volume which forms a sequel to that of Delambre, and which has been published by Biot and Arago. It is from thence that we shall take our general account of this method, the description of which will serve also for the explanation of the others, these having many points in common with it.

Fig. 3.



The fundamental principle of this method consists in employing for a pendulum a system of bodies which approaches the nearest possible in its properties to the simple pendulum, and which we can reduce to this ideal case by corrections equally simple to calculate, and exact in their application. The pendulum is formed by a ball of platina, suspended to a metal wire (fig. 3). The under extremity of the wire is screwed into the bottom of a spherical cap of copper, of the same radius as the ball, and which being applied on its surface with a little tallow, adheres to it in consequence of the pressure of the atmosphere, and of the perfect contact resulting from its sphericity. The other end of the wire is attached to a suspended knife (fig. 4), which oscillates on a plane of agate (fig. 5), furnished with adjusting screws, by which it can be brought perfectly horizontal; a circumstance which is ascertained by placing on this plane a glass spirit-level without its frame. The mass of the knife is previously adjusted, so that its oscillations may be very nearly isochronous with those of the clock, by which the whole pendulum must be regulated. This is done by the motion of a small ring of metal A, which screws round a metal rod T T fixed to the knife, and which, by screwing and unscrewing, approaches to or recedes from the plane of suspension, giving to the momentum of inertia of its mass a greater or less influence on the motion of the system of the knife and its rod. When the isochronism of the oscillations of the knife and of the clock is as perfect as can be obtained by this method, we suspend from the knife the wire and ball, giving to the wire such a length that the oscillations of the whole system may differ but little from those of the clock, consequently from those of the knife itself. It can then be shown, as well by calculation as by experiment, that the mass of the knife exerts no sensible influence on the length of the pendulum, which arises from its centre of gravity being then excessively near the plane of suspension. The whole system of the knife, the ball, and the wire, has only now to exert an effort infinitely small to complete the exact regulation of the oscillations of the knife, and to make them agree with those of the whole system.

Fig. 4.

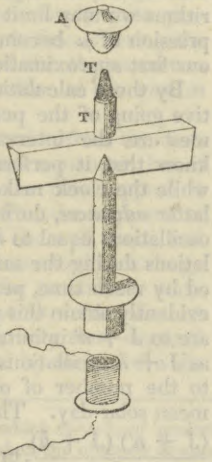
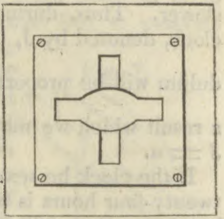


Fig. 5.



The pendulum is enclosed, with the clock, in a glass case, where it is exempt from the agitation of the air. Behind the wire, at a very small distance, is fixed horizontally a scale of equal parts, which serves to measure the amplitudes of the oscillations. Two sensible thermometers, carefully adjusted, are fixed near the wire, the one at the height of the plane of suspension, the other at the height of the ball, in order to indicate, at every instant, the temperature of the air around the wire. But as the wire, on account of the smallness of its mass, receives the impressions of temperature much more rapidly than the most sensible thermometer, the experiment is made in a room so large and sheltered, that the temperature of the air in it may change very slowly. The state of the thermometers is observed through the glasses of the case without ever opening it during the period of the oscillations.

Every thing being thus disposed, we place, at the distance of seven or eight metres, a telescope fixed horizontally, and the eye-glass of which has a wire fixed vertically before it. We direct this wire upon that of the pendulum when in a state of rest, and we then place in the same direction, on the ball of the clock, also at rest, a small circle of paper to serve for an index. These preparations being made, the clock is set to oscillate, and is no more stopped. When its rate of going has become very steady, we cause the pendulum also to oscillate, and shutting the door of the glass case, we proceed to observe it from without with the telescope. If it should move exactly at the same rate with the clock, it would always be found in the same position in relation to the index in all its consecutive oscillations. But this never happens, and the pendulum goes always quicker or slower than the clock. If it goes quicker, it only coincides for an instant with the index, after which it passes it, recedes from it, returns to it in the opposite direction, passes it anew, and, after having receded from it again, returns to coincide with it a second time, and follows its motion of oscillation for an instant. The telescope which serves to observe these separations and these coincidences magnifies the arc described by the pendulum and by the clock, augments their apparent velocity, and thus enables us to judge of the instants of coincidence with singular precision. Between two consecutive coincidences the pendulum gains or loses two oscillations upon the clock, and a simple proportion determines how much it must gain or lose in twenty-four hours of the clock if it be sexagesimal, or in ten hours if it be decimal. If we suppose N to denote the interval between two coincidences, in clock time, it follows, that while the clock makes N oscillations, the pendulum makes $N \pm 2$; the sign + being employed if the pendulum goes quicker than the clock, and the sign — if it goes slower. Thus, during any number of oscillations of the clock, denoted by J, the number of oscillations of the pendulum will be proportionally $J \left\{ \frac{N \pm 2}{N} \right\}$, or $J \pm \frac{2J}{N}$, a result which we may represent in an abridged form by $J \pm n$.

If the clock be sexagesimal, the number J of its beats in twenty-four hours is 86,400. If it be decimal, this number is equal to 100,000. Both these systems have been employed by the French observers. Whatever may be the one which we adopt, we regulate the length of the wire of suspension in such a manner that the coincidences of the pendulum with the clock may not be very near to each other, which would multiply unnecessarily the trouble of the observer. But neither must they be made too distant, because in that case the pendulum and the clock, detaching themselves too slowly from each other, the precise instants of each coincidence become more difficult to observe. A few trials will soon point out a convenient medium between these extremes. Then the difference in the diurnal rate $\pm \frac{2J}{N}$, or n, between the pendulum and the clock, always forms a very small number of oscillations. But the extent of the arcs described by the pendulum, diminishing always by the effect of the resistance of the air, while the clock, having its motion restored by the action of its weight, preserves always the same amplitude, it hence always happens that the intervals between the successive coincidences of the same pendulum vary with the time, which alters the value of the number n. During this inevitable change, the period when the coincidences are observed with the greatest precision is that where the amplitudes of the oscillations of the pendulum and of the clock are equal to each other; so that if we are obliged, by any consideration, only to observe a small number of coincidences, we must regulate the primitive range of the pendulum, so as to approach as near as possible this condition of equality.

The difference in the rate $\frac{2J}{N}$ or n corresponds with those oscillations of the pendulum which are performed between the coincidences which we compare together, that is to say, with an amplitude of arc varying from 2α at the beginning of the interval to $2\alpha'$ at the end of it. The duration of these oscillations is larger than if the oscillations had been performed with the same pendulum, but with amplitudes infinitely small; and, therefore, to render the results comparable with each other, they must be reduced to this latter case. For this purpose, at the moment of each coincidence, we observe, through the fixed telescope, the point of the horizontal scale at which the wire stops in its excursions on each side of the vertical. This furnishes sufficient data to calculate the angular deviation of the pendulum from the vertical, at the instant of the coincidence, since we know the distance of the scale from the plane of suspension at which the centre of rotation lies. We mark also the state of the interior thermometers, and that of the barometer, at the same instant. If the arcs α and α' are both very small, as it is usual to make them, we may, without sensible error, suppose all the oscillations made with the mean amplitude $\alpha + \alpha'$. Then, after what has been shown above, each of them, expressed in oscillations infinitely small, will be equal to $1 + \frac{1}{16} \sin.^2 (\alpha + \alpha')$, which we may express in an abridged form by $1 + \mu$, and consequently the $J + n$ oscillations of the pendulum supposed to be made in this arc will be equal to a number of oscillations infinitely small, expressed by

$$(J + n)(1 + \mu), \text{ or } J + n + \mu (J + n),$$

a result which we may represent in an abridged form by $J + n'$; the number n', according to what has been above established, never being any way considerable.

If the arcs 2α, $2\alpha'$ differ more than in a slight degree from each other, as, for example, when the interval between the coincidences which we compare is large enough for permitting the resistance of the air to have a considerable effect in modifying the first of these arcs, it will then be no more sufficiently exact to suppose all the oscillations made with the mean amplitude $\alpha + \alpha'$. But this inconvenience may be remedied, by observing experimentally the law of the gradual decrease of the amplitudes. This law is in geometrical progression when the number of oscillations increases in arithmetical progression; that is, if we begin with the instant when the half amplitude was α, and represent by α_n the amplitude which takes place after n oscillations, we find $\alpha_n = \frac{\alpha}{K^n}$, or because α and α_n are supposed very small, $\sin. \alpha_n = \frac{\sin. \alpha}{K^n}$; K being a co-efficient, which, in the same state of the air, is constant for the same pendulum, and depends on its length, its shape, and its other physical qualities. This law, first remarked by Borda, and since confirmed by the other French observers, is a necessary consequence of the smallness of the amplitudes, and of the feebleness of the resistance, which alters each amplitude in succession, proportionally to its extent. But however this may be, it is enough that it really subsists, to enable us to calculate by it the exact sum of the squares of the half amplitudes in the successive oscillations; a problem which is reduced to the summing of a geometrical progression of n terms, of which the ratio is $\frac{1}{K}$. This sum is simplified when we consider the extreme minuteness of the arcs which we compare, and by then pushing the approximation to their second power inclusively, which is the limit of the correction necessary for each individual amplitude. We thus find

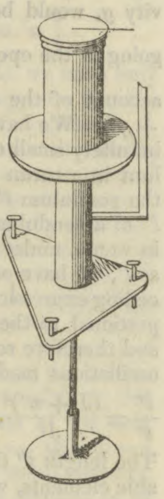
$$\mu = \frac{\sin. (\alpha + \alpha') \sin. (\alpha - \alpha')}{32 \, M \left\{ \log. \sin. \alpha - \log. \sin. \alpha' \right\}};$$

M being the modulus of the tables of common logarithms, or 2·30258509. If we suppose the arcs α and α' so small, that in the development of their series and of their logarithms we may limit ourselves to their first power, this expression of μ becomes what we have already obtained by our first approximation.

By these calculations we ascertain the rate of the relative going of the pendulum on the clock, which serves to measure the intervals between the coincidences. We know that it performs $J + n'$ infinitely small oscillations, while the clock makes J of them. Suppose now that the latter *advances*, during the mean solar day, a number of oscillations equal to h, that is, that it performs $J + h$ oscillations during the same time that a clock, exactly regulated by mean time, performs the exact number J, we shall evidently obtain this proportion; J oscillations of the clock are to $J + n'$ infinitely small oscillations of the pendulum, as $J + h$ oscillations of the clock, or a mean solar day, are to the number of oscillations of the pendulum during a mean solar day. The latter number is thus found equal to $\frac{(J + n')(J + h)}{J}$, or $J + n' + h + \frac{hn'}{J}$, the quantity which, for simplicity, we shall represent by $J + n''$. With the apparatus so disposed as we have described, if the clock is not very far from mean time, so that h denotes a small number of oscillations, the correction expressed by the last term, the only one which demands a calculation, will be of an extreme minuteness, and easily obtained with great precision.

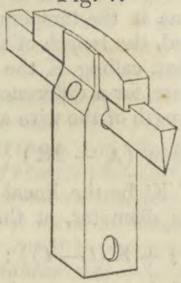
It now remains to measure the length of the pendulum from the plane of suspension to the bottom of the ball of platina. For this purpose we place beforehand, under this ball, a small plate of metal, well polished, perfectly horizontal, and which can be made to sink or rise vertically by means of a screw, of which the threads being very fine, permit the smallest motion. When the coincidences are finished, we open the glass case, and we raise gently this plane until it comes in contact with the ball of platinum. We must be equally careful to avoid raising it too much, which would raise the ball, and make the pendulum too short, or not raising it so high as the contact, which would give a pendulum too long; but if we take for an index the disappearance of a thread of light between the plane and the ball, at their common point of contact, we may then succeed, by a little skill, in fixing this contact with the utmost degree of rigour. This, however, is never done at the first attempt, for the entry of the observer into the glass case, however short, always elevates in a slight degree the temperature of the air contained in it, and consequently that of the wire, which acquires this temperature in the same instant, from whence arises a small increase of its length, which we ought to be aware of. On this account, instead of establishing a perfect contact between the plane and the ball, in that accidental state of the wire which the interior thermometers, less sensible than it, do not perhaps indicate with sufficient exactness, it is better to confine ourselves at first to the mere preparing for the operation, by making the little plane approach extremely near the ball, without, at this time, actually touching it. We observe now the point where the index of the screw that moves the ball stops, and then coming out of the glass case, we shut it until the temperature within, and the thermometers which measure it, have had time to return to a state of rest. We then open the case anew, and finish in an instant the operation of contact, which is easily done, as we have only to give to the plane of contact a very slight degree of motion, and such as we are previously quite prepared for. At this moment, or rather before entering the glass case, we mark the temperature of the thermometers within, and consider this as the temperature of the wire at the instant of contact.

Fig. 6.



The distance of the plane of suspension from the bottom of the ball is now fixed, and in such a manner that it is henceforth invariable, or at least we may suppose it such during a long interval of time. For, the supports of the plane of suspension being fixed in the wall itself, and those of the plane of contact being cemented to a large stone resting on this wall, or sunk into the ground, the accidental variations of temperature cannot alter the distance which separates them, excepting in a very slow degree.[1] It remains then to measure this interval by means of a divided rod of metal; but to determine the length of such a rule, its extremities must be quite free; and how can we, in that case, apply its summit exactly on a level with the plane of suspension? Borda has very happily resolved this difficulty, by adapting to one of the extremities of the rule a knife of suspension, which is fixed to it, so as to touch it on its edge. Suppose we wish first to measure the length of the rule, we take off the knife, and apply the rule itself to the apparatus intended for that object. If we wish then to measure the length of the pendulum, we replace the knife, and suspend the rule, thus armed, on the plane of suspension, in place of the pendulum itself. In our experiments, the knife is adapted to the rule by means of a metal case; the rule is inserted into this case until it touches the knife, when it is fixed in this position by means of a strong pinching screw, denoted by V, and which is screwed by an iron key. It only remains to alter the length of this rule in such a manner as to render it exactly equal to the actual distance which is found between the bottom of the ball and the plane of suspension. For this purpose, in the experiments of Borda, the rule carried, on its under part, a divided tongue, having a free motion. When the observations of the coincidences were finished, the pendulum was removed, and for it was substituted this rule, of which the tongue was let down until it fell upon the little plane which had touched the ball of the pendulum. Then, by reading, with a magnifying glass, the divisions of the tongue, it is easy to know the distance between the bottom of the ball and the axis of suspension.

Fig. 7.



In Borda's experiments, the pendulum was twelve feet long. A rule of such a length could not have been carried in travelling, or even in stations of difficult access, without the risk of serious errors, resulting from the bending which it must have received. On this account the French observers, who were intrusted with such experiments, thought it necessary to modify in this point the apparatus of Borda, and they confined themselves to pendulums much shorter; as are those which swing mean sexagesimal or mean decimal seconds. This enabled them to make use of rules much shorter, more portable, and which they could also make larger and more solid without increasing too much their weight; but then it became indispensable to introduce a still greater degree of precision than before into the determination of the length of the rules; into that of the divisions traced upon the tongues which were fixed to them; and, lastly, into the measurement of the variable parts of these tongues, which were used in each experiment, in order to adapt them to the different lengths of the pendulum which they were intended to measure. All these elements were obtained with unexpected exactness, by employing for their determination the apparatus already used with such success for the comparison of metrical scales, under the name of *comparateur*. All the details of this application may be seen in the work of Biot and Arago, above referred to.

By means of the operations above described, we find the total length of the pendulum, from the plane of suspension to the bottom of the ball of platina; such at least as it is at the instant of contact of the latter with the little plane. But this length may not be, and is not in general, the same which the pendulum has when it began to oscillate; because the temperature, which modifies almost instantaneously the length of the wire, cannot have been the same at the time of the contact of the plane, and during the observation of the coincidences. But it is to this state that we must evidently reduce the length that we have attained. For this purpose, let it be denoted by Λ, and suppose t' the temperature of the wire in degrees of the thermometer at the instant of contact, t being its mean value during the coincidences; then if R' represent the radius of the ball of platina at the temperature of t' when the contact was produced, the length of the wire at that instant was $\Lambda - 2R'$; so that, calling K the lineal dilatation of the matter of the wire, for a difference of one degree in the temperature, the length of the wire at the time of the oscillations must have been $(\Lambda - 2R')\left\{1 + K(t - t').\right\}$ In the same manner, if K' be the lineal dilatation of the substance of the ball, its diameter, at the time of the oscillations, will be $2R'\left\{1 + K'(t - t')\right\}$; and adding this quantity to the length of the wire, we obtain $\Lambda + \Lambda K(t - t') + 2R'(K' - K)(t - t')$ for the distance of the plane of suspension from the bottom of the platina ball during the actual time of the oscillations. By deducting from this length the radius of the ball, such as it was at the same instant, that is, $R'\left\{1 + K'(t - t')\right\}$, we shall have the distance of the centre of the ball from the plane of suspension, a distance which we shall call h. This being determined, if the wire which sustains the ball, and the cap which fits upon its surface, were both without weight, or if their weight could be altogether neglected in comparison with that of the ball, the length l of the simple pendulum isochronous with the compound one thus formed would be obtained by the above formula, and would be $l = h + \frac{c'}{mh}$, m being the mass of the ball, and c' its momentum of inertia relative to an axis drawn through its centre. But calling ϱ the density of the mass of the ball, and R its radius, at the temperature at which the pendulum oscillates, its mass m is equal to $\frac{4}{3}\pi\varrho R^3$, and the value of c' is $\frac{8}{15}\pi\varrho R^5$. Substituting these values, we have $l = h + \frac{2R^2}{5h}$; hence it appears, that it would be easy to calculate l, since R and h are known. But, in truth, the weight of the wire and that of the cap can never be absolutely nothing. They are only very small, relatively to the weight of the ball; so that the preceding value of l is but an approximation, which, to become quite exact, requires a small correction, depending on the relation of these masses. This correction being rather complicated in its expression, we shall not repeat it here, but refer to the memoir of Borda, or the work of Biot and Arago, already mentioned, and represent it by Q; as it is always negative, the length l of the simple pendulum isochronous with the pendulum observed will become $l' = h + \frac{2R^2}{5h} - Q$. Now we have seen, that, in these experiments, the apparent gravity which impels the pendulum is less than the real gravity which operates in vacuo, on account of the statical effect of the ambient medium; but for a simple pendulum of the length l moved by the force of gravity g, the time T of its infinitely small oscillations is expressed by $\pi\sqrt{\frac{l}{g}}$; and if we wish to obtain oscillations of equal duration with different forces of gravity, we must vary the lengths in proportion to these forces, so that the relation $\frac{l}{g}$ may remain constant. Now, after what we have before seen, if we denote by D the density of the substance of the pendulum at the temperature of freezing, and under the atmospheric pressure of $0^m{\cdot}76$, that of the air being 1, if, besides, we denote by c the cubic dilatation of this same substance, the relation of the apparent gravity in air to the gravity in vacuo, under the pressure p, and at the temperature t, will be expressed by $1 - \frac{p}{0^m{\cdot}76\,(1 + t.0{\cdot}00375)(1 - ct)\,D}$, which, for simplicity, may be represented by $1 - \gamma$. Then, to obtain the length l'' of the simple pendulum, which, making its oscillations in vacuo under the influence of the gravity g, would be isochronous with the actual pendulum l', going in the open air, we must take $l'' = \frac{l'}{1 - \gamma}$, which, on account of the smallness of γ, may be reduced to $l'' = l + \gamma l'$. We have denoted above by $J + n''$ the number of infinitely small oscillations performed by the actual pendulum in a mean solar day. Such, then, is also the rate of the pendulum l''. If we wish, in fine, to obtain the length l''' of a pendulum which would move exactly to mean time in vacuo, under the influence of the same power of gravity as l'', we have only to consider that, according to the preceding expression of T, the lengths l'' must be directly proportional to the squares of the times of their oscillations, and therefore reciprocally as the squares of the number of oscillations made in equal times. We must take, then, $\frac{l'''}{l''} = \frac{(J + n'')^2}{J^2}$, whence we obtain $l''' = l''\frac{2n''\,l''}{J} + \frac{n''^2 l''}{J^2}$. The length l''' thus obtained is now free from all the variable elements, which depend on particular circumstances of their observations. This constitutes what we should properly call the absolute length of the simple pendulum in the place of observation.

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[1] Considering the indispensable necessity which there is of preserving rigorously this quantity invariable, it appears to be of extreme importance that the ground may not yield when the observer approaches to complete the measurement. The only means of avoiding, beyond suspicion, this possibility, is to construct round the pendulum a platform, supported on certain points of the ground, at a distance from the stone which carries the little plane with which we effect the contacts of the ball, so that this apparatus may become quite independent of the motions of the observer.

The experimental method which we have described, when it is employed with all due care, gives results which, in the same place, are perfectly comparable with each other. For, with various lengths, such as the sexagesimal pendulum, for example, or the decimal pendulum, the deductions from particular experiments do not differ generally from each other more than in the thousandth parts of a millimetre. To establish, however, completely the theoretical certainty of this method, it is necessary to examine more particularly some of the circumstances which form a part of it.

Our first remark relates to the extensibility of the wire to which the platina ball is suspended. It is clear, that, during the period of each oscillation, the wire is impelled in the direction of its length by two forces of different kinds, and of different intensities; of which the one is the varying traction, acting on it every instant by the weight of the ball decomposed into its direction; and the other is the centrifugal force, which the motion of oscillation generates. It may evidently be a question, whether this double action has not on the oscillations a sensible influence, which, disappearing in the measurement of the length taken when the pendulum is at rest, would alter the result which we have obtained. M. Poisson has submitted this question to calculation in the eighth volume of the *Journal de l'Ecole Polytechnique*, and he has found, first, that the symmetry of the oscillations on each side of the vertical is not altered by the extensibility of the wire; at least if we suppose them to be performed in vacuo, a circumstance which it was easy to anticipate from the symmetry itself of the mode of action of this force. But he has found that their duration is affected with a periodical inequality, in consequence of which the successive oscillations are not isochronous among themselves. When the total extension, however, suffered by the wire is very small, which is generally the case in experiments where the wires are formed of metallic substances, the effect of this inequality neutralizes itself in the mean duration of a great number of oscillations; only this mean period is a little longer than if the wire had been altogether inextensible. Let *l*, for example, be the lineal length which the wire would naturally have if left to the sole attractive action of its particles on each other; and suppose that, by suspending the platina ball at its lower extremity, it lengthens by a small quantity λ. This being the case, if the half amplitude of the oscillation is denoted by α, M. Poisson finds that, limiting the results to the square of α, the mean duration T of the whole oscillations will be

$$T = \pi\sqrt{\frac{l}{g}}\left\{1 + \frac{1}{16}\left(1 + \frac{11\lambda}{l}\right)\sin.^2\alpha\right\}.$$

If we wish to suppose the wire inextensible, we have only to make λ equal to nothing, and it hence appears that the extensibility only modifies the correction of amplitude, already in itself so small, and alters it by a quantity which, from the small extensibility of the metals, cannot in general produce any effect that could be detected by observation.

A second circumstance, which deserves equally to be examined, is the probable influence of the motion of rotation of the platina ball round the direction of the wire, and any twisting which the wire may suffer during the oscillations. M. Poisson has examined, by a calculation in the *Connoissance des Tems* for 1815, the effect of such a motion; and he has found that, in the ordinary disposition of the pendulum of Borda, it is rendered in a manner insensible by this circumstance, that the momentum of inertia of the ball, and of the whole pendulum, relatively to an axis drawn through the direction of the wire, is a very small quantity. Let R be the radius of the platina ball, *h* the distance of its centre from the axis of suspension, α the angle which the rotation of the ball makes each of the points of its surface describe during the period of an oscillation, this angle being measured in a circle of a radius equal to 1, T the time of an infinitely small oscillation of the same pendulum, in the case when the rotation is nothing; M. Poisson finds that the real duration of the oscillations will be $T\left\{1 - \frac{\alpha^2 R^4}{50h^4\pi^2}\right\}$, π being always, as before, the circumference to the diameter, which is unit, or, what is the same thing, the semi-circumference, of which the radius is 1. In regard to the effect of the torsion communicated to the wire by the rotation of the ball, M. Poisson proves that it can have no influence on the duration of the oscillations. In the shortest lengths of pendulum which have been observed by the above process, R was less than $0^{m}{\cdot}02$, and *l* nearly equal to $0^{m}{\cdot}74$. Adopting these numbers, and supposing, besides, that the ball describes two whole circumferences for each oscillation, which would be a very rapid motion of rotation, we shall then have $\frac{R}{h} = \frac{1}{37}$, $\frac{\alpha}{\pi} = 4$, and consequently $\frac{\alpha^2 R^4}{50h^4\pi^2} = \frac{1}{5856569}$; whence it appears that the time of the oscillation would be diminished only by a quantity altogether insensible, even on the above suppositions. But it is far from being the case that a rotation so rapid as we have supposed really takes place in the experiments; on the contrary, when we set the pendulum in motion, we take great care to avoid every movement of this kind; we also pay particular attention to let fall the ball without any lateral impulse, so that its oscillation may be performed as exactly as possible in a vertical plane, which we also take care to verify by observation, when the pendulum is in motion. It would be useless to attempt to obtain this condition in a manner more exact; for it is known by the calculation of conical oscillations, that when these take place in an orbit much flattened, their duration is almost exactly the same as if they were quite plain.

The last object to be considered, and of which the discussion is as important as it is delicate, is the influence which the form of the suspending knife may have upon the oscillations of the same pendulum. Comparing, indeed, the motion of the pendulum to that which would take place round an axis of suspension perfectly rectilineal and mathematically straight, we suppose, or at least seem tacitly to suppose, that the edge of the knife forms such an axis, which is physically impossible, since the most perfect art cannot give it any other form than that of a round surface, the breadth of which is sensible to the microscope, and which, even there, appears always like a saw indented with teeth more or less deep. Now, if this surface were a circular cylinder, a simple calculation, which was first made by Euler, shows that the durations of the oscillations will be the same as if they were performed round a rectilineal axis placed *under* the surface of the cylinder, and at a distance equal to the radius of its curvature; and in the case of very small oscillations, this result may be extended to a knife of any form, if we take for its curvature that of its osculating circle. Hence it follows, that in order to have the true length of the simple pendulum in this circumstance, we must subtract the radius of this circle from the length calculated on the hypothesis of a rectilineal axis, according to the oscillations observed. But such a correction would throw great uncertainty upon the results; for the osculatory curvature of the knife cannot be measured, or even appreciated, by any process, and it must vary considerably, either by the difference of workmanship in different knives, or by the inevitable wearing which the edge of the knife undergoes when the weight suspended from the wire presses it against the plane of suspension. Fortunately, the extent, and the variableness itself, of the effects which this cause should produce, serve to prove that it has no action whatever in experiments; for, in the first place, by loading successively the head of the same knife with several weights very different among themselves, in order to observe if these different systems, previously according with the same clock, would have an influence on the length of the pendulum, Borda has found that this influence was absolutely insensible, although the curvature of the edge, to which he did not pay attention, was then undergoing very different modifications under the unequal compressions to which they were subject. Secondly, the length of the simple pendulum, beating seconds at the Observatory of Paris, which Borda had deduced from a pendulum of twelve feet long, has since been found as exactly the same as the difficulties of the operation would permit, by employing, with the same knife and the same ball, wires four times shorter, which gave a much greater influence to the alterations of length which the curvature of the knife could produce. Lastly, by observing successively, at the same place, with the same ball, and the same length of wire, but with knives whose edges presented an extreme diversity, from the highest possible finish to the greatest coarseness in the execution, M. Biot has obtained, at Leith Fort, in Scotland, such lengths for the simple pendulum, between which no sensible difference could be observed, although no correction whatever was made for the curvature of the knife. These proofs of different kinds, but all agreeing in their consequences, seem to show evidently that in the process of Borda the shape of the edge of the knife has no sensible influence on the results, and that it is unnecessary, therefore, to pay any attention to it; and yet, as the theory of oscillations round cylindrical axes cannot be questioned, we must either conclude that in this circumstance the oscillation is really not performed on a cylinder of sensible dimensions, but upon the ideal axis of insensible dimensions, formed by the asperities which still exist in the grain of metal of which the knife is composed; or that the agreement previously established between the proper motion of the knife and the total motion of the pendulum, compensates physically the effect which the curvature of the knife would have upon the oscillations, if it consisted really of a simple cylinder without mass attached to the wire.

II.—METHOD OF KATER.

The method employed by Captain Kater to measure the length of the pendulum is founded upon this theorem of Huygens, that whatever be the form of the oscillating body, the centre of oscillation and the centre of suspension are reciprocals to each other, a theorem of which we have already given the demonstration. To realise this disposition, Mr Kater chose a body of such a form that it was easy to determine by calculation the approximate position of its centre of oscillation for a given position of the axis of suspension. These two points being thus known, he fixes there immoveably two knives parallel to each other. In the space which separates them he then adapts to the body a moveable weight, and having first placed it at random, he makes the system oscillate successively upon the one knife and upon the other. If, as it almost always happens in the first trial, the oscillations performed in the two cases are of unequal duration, he moves the intermediate weight, so as to bring them nearer to an equality; then, comparing these anew by observation, he finds necessarily a less disparity between them, which he again reduces, until at last, after a few trials, the duration of the oscillations performed round the two axes become exactly equal. The justness as well as the rapidity of these reductions are favoured by the form which Mr Kater has chosen for his oscillating body. This form is a simple rectilineal bar of brass, towards the two extremities of which are placed two known weights; the one of which is immoveably fixed, and the other, being moveable, but at the same time capable of being fixed in a similar manner, serves, first, by its motion, to establish between the two knives, not exactly, but approximately, that reciprocity between the oscillations to which it is desired to bring up the system. This reciprocity is then rendered rigorously exact, by the much more delicate motion of a third smaller weight placed between the knives, in that part of the rod where we know, by calculation, the effect of its displacement will have the least sensible influence upon the oscillations, which is found to be towards the middle of the rod, in the division of the weights adopted by Mr Kater. A divided scale, engraved upon the bar of the pendulum itself, serves to measure the displacement of this latter moveable weight. In the experiments of Mr Kater, this scale was divided into twelfths of an inch, and a displacement of twelve parts produced a difference of about four seconds in the diurnal rate of the system, reckoning sexagesimally; whence we may be able to appreciate the extreme delicateness of this mode of regulation. The bar, with its weights, is represented in fig. 1, Plate CCCCIII. Fig. 2 shows its disposition during the observations.

It is then, as appears, placed before a clock, with which it is compared, by means of a fixed telescope, after the method of coincidences of Borda. But the mode of experiment employed by Kater, requiring the oscillations round the two axes to be observed in a state of rigorous equality, it becomes necessary to avoid, in their comparison, every change of temperature, and thus it is necessary to make the results independent of the variations of this kind which inevitably arise in the atmosphere. That could only be obtained by rendering the series of coincidences very short, and multiplying the successive inversions of the apparatus. But then, to obtain the same exactness, it is necessary to fix the coincidences with much greater precision than in the method of Borda, where the little influence which they have is one of the principal advantages. Mr Kater has attained this object, by fixing upon the lentil of his clock a white disc, traced upon a black ground, and of such a size that it is exactly covered, and no more, by the interposition of the bar of the pendulum, when this is at rest in the situation of the vertical. This same occultation, being then observed during the motion of the clock and of the pendulum, serves to fix the instant of the coincidence; and Mr Kater finds, that in this manner there cannot be any error greater than a second on the instant to which each coincidence belongs.

The rest of the details of the observation are the same as in Borda's process. The amplitude of the arc of oscillation is observed at each coincidence, as well as the state of the barometer and thermometer; and these are employed in the same manner to reduce the oscillations to what they would have been if they had taken place in vacuo, and with amplitudes infinitely small, at the observed mean temperature of the oscillating body.

It still remains to obtain the length of the simple pendulum corresponding to this rate of going. After an equality has been obtained in the oscillations round the two knives, this length is equal to the distance between the edges of the knives at the moment of the oscillation of the pendulum, at least if we consider these edges as lineal axes. It would be evidently impossible to observe the distance in question during the actual motion of the pendulum; but this defect may be supplied by determining it first for some known temperature, and reducing it by calculation to the value which it ought to have during the coincidences, according to the temperature at the time these took place, and the dilatation of the substance of the pendulum, which is also known. It is thus that Mr Kater operated, and he has obtained the true distance between the knives, in comparing it by a microscopic process, with the metal rule which he employed as a standard of measure. In order that this operation may be put in practice, the two edges of the knives must be very exactly parallel. Mr Kater accordingly disposed them in this manner before the experiments, employing the measure itself of their distance to determine and to prove the accuracy of their position, to which they were gradually brought by means of adjusting screws, which allowed each knife to move by very small displacements. He also took advantage of this method to render their direction quite perpendicular to the length of the bar. Lastly, as the distance between the knives, which we are seeking to determine, is that which took place when the pendulum was in a vertical situation, Mr Kater, during the measurement, applied to the bar, now horizontal, a force of longitudinal traction equal to what it exerted on itself by its own weight, and in a state of oscillation. In calculating the influence which the curvature of the knives, supposing it to be circular, can have upon the length of the simple pendulum, deduced from the oscillations of a similar apparatus, M. Laplace has found it to be equal to nothing, and that this length was always rigorously equal to the distance between the edges of the knives. This theorem is only true on the supposition that the two edges are of the same curvature; but whatever precaution may be taken to render them identical, even making them together, and with a single piece of steel, it will be impossible to be assured that there may not be found differences, not merely very small, but very considerable, in the radii of curvature of their osculatory circles; since these circles are the result, not of any measured and geometrical operation, but of a work of reducing and polishing necessarily vague and irregular. It would appear then by this, that the results of this method would still be subject to the same uncertainty in theory as the results of the others are; but these uncertainties are dispelled in both cases, by the experimental proofs already described, that, in the process of Borda, the figure of the edge of the knives has no influence upon the length of the simple pendulum, deduced from their oscillations. In short, what completes the proof, that these two methods do not include in themselves any source of inaccuracy, is the surprising and almost ideal coincidence of the results which they afford, notwithstanding the diversity of the two processes. We shall have occasion to give a striking proof of it at the conclusion of the ensuing paragraph.

III.—PENDULUMS OF COMPARISON.

The two methods which we have been explaining make known the *absolute* lengths of the simple pendulum in every place where it is observed. Both of them, therefore, require to be absolutely determined, on the spot, in lineal measures; and this cannot be done with sufficient exactness but by a process of extreme delicacy, the practice of which implies numerous preparations. But when we wish merely to determine the ratios of the lengths of the simple pendulum to each other, for different places on the earth, we may obtain this without any absolute measurement, and by the mere comparison of the oscillations made in these places in equal times by a compound pendulum of any form. To demonstrate this, suppose, first, that the figure of the mass of this pendulum is quite invariable, and that it suffers neither dilatation nor contraction by the changes of temperature; or, what comes to the same thing, suppose the observations are always made during temperatures exactly equal; in this case, according to the formulæ laid down in the beginning of this article, the length l of the simple pendulum isochronous with that compound pendulum, may be expressed by $\frac{c}{mh}$, m being the mass of the oscillating body, h the distance of its centre of gravity from the axis of suspension, and, lastly, c its momentum of inertia; that is to say, the sum of all the elements of its mass, multiplied by the squares of their respective distances from the axis of suspension. This length l, then, will be the same in whatever place we observe it, since its analytical expression depends only on the figure of the oscillating body and the density of its parts, but in no respect on the intensity of the gravitating force which impels it; so that if we take any compound pendulum, of any form whatever, but having its mass and figure constantly the same, and make it oscillate successively in different parts of the earth, it is the same thing as to cause a simple pendulum to oscillate successively in the same places. But, supposing the oscillations performed in vacuo, and with infinitely small amplitudes, or, what is the same thing, supposing them reduced to these conditions by calculation, the durations T', T'' of the oscillations of the same simple pendulum, whose length is l, are connected with the intensities g', g'' of the gravitating force, which impels them by the following relations, $T'^2 = \pi^2 \frac{l}{g'}$, $T''^2 = \pi^2 \frac{l}{g''}$; whence we obtain $\frac{g''}{g'} = \frac{T'^2}{T''^2}$, that is to say, that the intensities of the gravitating forces are reciprocally as the squares of the times of the oscillations; or, what is the same thing, they are directly proportional to the squares of the numbers of oscillations made in equal times. For let N', N'' be these numbers, and T the total time which corresponds with them, then T' will be equal to $\frac{T}{N'}$, and T'' equal to $\frac{T}{N''}$; so that, by substituting their values, the preceding relation will become $\frac{g''}{g'} = \frac{N''^2}{N'^2}$.

By such experiments, then, made with the same compound pendulum, we may be able to determine the relative forces of gravity in the different places of observation. But we may, with equal facility, deduce from them the ratios of the absolute lengths which it would be necessary to give to two simple pendulums in the same places, for making them bear an equal number of oscillations in a given time; for example, to beat the mean second. For let λ', λ'' be these unknown lengths, since the corresponding times of oscillation are each one second, we shall have by our general formulæ $1''^2 = \frac{\pi^2\lambda'}{g'}$, $1''^2 = \frac{\pi^2\lambda''}{g''}$; whence we obtain $\frac{\lambda''}{\lambda'} = \frac{g''}{g'}$; that is, that the lengths required are proportional to the intensities of gravity in the two places. But we have seen that the ratio of the gravitating forces may be deduced from the observations made with the same compound pendulum; and introducing this determination into the preceding expression, we obtain $\frac{\lambda''}{\lambda'} = \frac{N''^2}{N'^2}$. Hence, when we have observed the numbers of infinitely small oscillations made in two different parts of the earth, by the same compound pendulum, of a constant form, the ratio of the squares of these numbers will be equal to the ratio of the lengths of the simple pendulums, which swing seconds in the same places. All these results suppose, as we have seen, that the mass and form of the compound pendulum are rigorously the same at the two stations. To obtain a degree of permanency in the mass, we form the pendulum of metal, cast in one piece, to which we adapt for suspension a knife edge made by a process which insures the firmness of the connection, and we take every precaution possible to prevent any physical or chemical alteration from modifying it during the carriage. But the permanency in its dimensions and figure is much more difficult to be obtained, because the inequalities of temperature in the different places of observation, and the accidental variations of natural heat, even in the same place, tend perpetually to disturb it. It is physically impossible to prevent the effects of these alterations in any other way, than by preserving constantly round the pendulum the same artificial temperature; a method which has been really employed, but which requires very great precautions to render the temperature round the pendulum uniform, and a constant attention to manage the sources of cold and of heat, in order to maintain it at the same fixed degree. It is on this account more simple, and perhaps more accurate, when the thing is possible, to dispose the experiment so as to have only very slow changes of temperature; then to allow the pendulum to partake of these changes, and to correct this effect on its form by calculation, from the observation of the temperature, and the knowledge of the proper dilatation of the substance of which it is composed. This correction is extremely easy; for if we resume the expression $l = \frac{c}{mh}$, which expresses the corresponding length of the simple pendulum, the momentum of inertia c is of the same order as the mass, multiplied by the square of the dimensions of the oscillating body, and the denominator mh is the product of this same mass by a single dimension; whence it is easy to conclude, that if the dimensions should vary in the same proportion in every direction, which really happens in changes of temperature, the quantity $\frac{c}{mh}$ will vary according to this simple proportion. Hence, if we name l the length of this simple pendulum, isochronous with the compound pendulum, when the latter is at the standard temperature t, and denote by l' the analogous length when the temperature is t', representing also by K the lineal dilatation of the mass of the pendulum, for a change of one degree of the temperature, and for a length equal to unity, we shall evidently have $l' = l \; \{1 + K(t' - t)\}$. Suppose now the pendulum l' has made a number N′ of oscillations in a given interval of time, for example, a mean solar day, it will be easy to calculate how many the standard pendulum l would have made in the same time, if it had been acted on by the same force of gravity; for the squares of the numbers of oscillations made in equal times being reciprocally as the lengths of the pendulums which perform them, the square of the number sought will then be

$$\frac{N'^2 l'}{l}, \text{ or } N'^2 \left\{ 1 + K(t' - t) \right\}.$$

Hence we obtain for this number itself $N' \sqrt{1 + K(t' - t)}$; or, reducing the radical into a series, and limiting it to the first power of K, $N' + \frac{1}{2} N' K (t' - t)$. This approximation is always sufficient, because the co-efficient K of the lineal dilatation is always very small in solid bodies, and the difference $t' - t$ of the natural temperatures in the places of observation can never exceed a small number of degrees. Captain Kater, for example, has operated with a similar pendulum, made of brass, the observed lineal dilatation of which was 0·00000982 for one degree of Fahrenheit. In an experiment made in London, this pendulum was found to perform a number of oscillations equal to 86051·32, the temperature being 71°·6. If we wish to reduce this experiment to the standard temperature of 62 degrees, which was adopted by Mr Kater, we shall have $N' = 86051·32$, $K = 0·00000982$, $t' - t = + 9°·6$, whence we obtain, for the correction of the temperature, $\frac{1}{2} N'K (t' - t) = + 4''·04$, that is to say, four oscillations, and four hundred parts, added to the number of oscillations observed. By operating in the same manner in every other case, we can reduce all the observations to the constant temperature once fixed as a standard.

But one of the indispensable elements in this reduction is the actual temperature of the pendulum during the experiments, and some precautions are necessary to obtain it with exactness. For the pendulum being always very large compared with the thermometers, which we can place by the side of it, it partakes much more slowly than them of the variations of temperature, so that it ought always to be a little colder than the thermometers when the temperature of the air is rising, and a little warmer when it descends. It would be impossible to estimate these differences of state; but we can render their effect insensible, by operating in a room, so large and sheltered form the sun that the temperature remains in it nearly constant, or at least suffers such slow variations, that the mass of the pendulum has time to partake of them. For in that case the thermometers will point out the state of this mass in indicating that of the ambient air; or if there remains some difference between both, the effect of this will disappear by compensation in a series of experiments sufficiently repeated.

We have mentioned above, that the corrections relative to the amplitude of the arcs and the density of the air, are made in every place for the compound pendulums, the same as in the experiments with the absolute pendulum. The duration of the oscillations may also be determined in the same manner by the method of coincidences, comparing the experimental pendulum with a clock that is actually regulated by astronomical observations. Thus, in applying this process, and these corrections, we shall obtain the numbers of oscillations which a compound pendulum would have made at the different stations, if it had oscillated in vacuo, and at a temperature always constant. Whence we may then deduce the relation of the intensity of gravity at these stations, or the ratio of the lengths of the simple pendulum, swinging the same fixed number of seconds in a given time.

To give an example of this deduction, we shall relate the following result, obtained in 1818, by Captain Kater, with the same compound pendulum the dilatation of which is stated above. The numbers of oscillations expressed in the last column are reduced by calculation to the case of amplitudes infinitely small, the pendulum in vacuo, and the temperature being the standard of 62° Fahrenheit.

Names of the Places.	Latitudes of the Stations.	Number of Oscillations of the Compound Pendulum in 24 mean Solar Hours.
London.......	51° 31′ 8″	86061″·30
Leith Fort...	55 58 37	86079 ·22
Unst..........	60 45 25	86096 ·84

From other experiments previously made by means of the method of inversion, Captain Kater had determined the length of the absolute seconds pendulum at London, precisely at the same place, and in the same room, where he since made his compound pendulum oscillate. This length, expressed in English inches, on Sir George Shuckburgh's scale, was found to be 39·13908 inches. If then we call this length λ, and λ′, λ″ the analogous lengths for the two other stations of Leith and of Unst; also N, N′, N″ the number of oscillations of the portable pendulum in these three stations, we shall have, according to the formulæ above laid down, $\lambda' = \lambda . \frac{N'^2}{N^2}$, $\lambda'' = \lambda . \frac{N''^2}{N^2}$, which will give for the length of the simple pendulum, at the station of Leith, 39·15538 inches, at the station of Unst 39·17141 inches. Now, by comparing, by methods of extreme precision, the scale of Sir George Shuckburgh, with a metre of platina, executed under the directions of the Board of Longitude of France, and verified by a commission of several members of this body, Mr Kater has found that the metre, taken at its own standard temperature, which is that of melting ice, is equal to 39·37079 inches of the scale of Sir George Shuckburgh, taken also at its own standard temperature, which is 62 degrees Fahrenheit. Hence it follows, that any length l expressed in inches of this scale, taken at its standard temperature, is equal in millimetres to $\frac{1000 \cdot l}{39·37079}$. The preceding lengths of the simple pendulum, both at Leith and Unst, being already reduced to this standard state, we may apply to them directly this formula, and deduce in millimetres the following values, which are set down, compared with those of Biot, obtained by the method of Borda, from observations made with great care, the preceding year, in the same stations of Leith and Unst.

Names of the Stations.	Lengths of the Simple Pendulum according to Kater.	Lengths of the Simple Pendulum according to Biot.	Differences of Kater's Measurement.
	m m	*m m*	*m m*
Leith Fort	994·528685	994·524453	+ 0·004232
Unst.........	994·935840	994·943083	— 0·007243

The differences of the results, it will be seen, are excessively minute, for they consist only in some thousandth parts of a millimetre, which is equal to $\frac{39}{1,000,000}$ of an English inch; and they are, besides, affected with contrary signs at Unst and at Leith. We may reasonably conclude, then, that they fall within the limits of that uncertainty to which all physical results are subject; and it may therefore be inferred, that the method of Borda and that of Captain Kater are equally precise, and both give, with exactness, the absolute measure of the pendulum.

In attempting to carry compound pendulums on distant journeys, or when we are obliged to observe them in places where the apparatus cannot be fixed to solid buildings, this must necessarily be modified, so as to be complete in itself. To do this, we may prepare for the pendulum a support of metal, made from a single casting, the feet of which spreading out, can be firmly fixed in the ground, while they allow the pendulum, at the same time, to oscillate at freedom between them. The upper part of this support must consist of a plate having a longitudinal opening in it, to allow the stem and knife of the pendulum to pass through. On this is fixed, with long screws, a polished plate pierced with a similar opening, and which can be set horizontally with a spirit-level before fixing it; and it is on this plane that we place the knife of the pendulum. A divided scale, unconnected with the pendulum, is placed horizontally, immediately under the lower extremity of its stem, which being furnished with a point, indicates, by its excursions upon this scale, the amplitudes of the oscillations. In order, now, to determine the rate of the pendulum's going, it is not always possible to procure the necessary facilities for employing the method of coincidences. In that case, we may substitute for it the comparison of the pendulum with an adjoining clock, or else with a chronometer, counting, as Bouguer did, the whole oscillations which the pendulum performs during a given time, and determining the fractions of oscillations, by observing the part of the amplitude with which the point of the stalk corresponds at the commencement and termination of the interval of the time observed. But in making use of this last process, which is indispensable for fixing the extreme terms of each compared interval, we can dispense with the counting of the oscillations one by one; for it will be sufficient to follow them with a counter, the rate of which is adjusted very nearly to that of the experimental pendulum, and which we take care from time to time to regulate according to it; accelerating or retarding its motion by an impulse given to its lens before it has lost or gained a whole oscillation. This last part of the proceeding has been suggested by M. Arago, and employed by Captain Freycinet in his voyage round the world. Then it only remains to fix, by observation, the position of the stem upon the arc of amplitudes at the periods of comparison with the chronometer or the clock, and from thence to deduce the fractions of oscillations which the counter could not indicate. These fractions may be obtained from the mathematical law which regulates the motion of the pendulum in each oscillation. If we call 2α the whole amplitude with which the pendulum oscillates, and T the total time which it takes to describe it, also ε the arc which it describes, during the time t, in falling from the extremity of this amplitude, the law of the descent, limited to small amplitudes, gives $\varepsilon = 2\alpha \sin.^2 \left\{ 90° \cdot \frac{t}{\mathrm{T}}, \right\}$ so that, by representing the half amplitude α by 1000 parts, and supposing t successively equal to $\frac{1}{10}$th, $\frac{2}{10}$ths, $\frac{3}{10}$ths of T, or of the duration of a whole oscillation, we obtain for ε the following values.

Values of t in 10ths of the whole Oscillation.	Portions of the Half Amplitude described.
1	48·9
2	191·0
3	412·2
4	691·0
5	1000·0

It would evidently be of no use to push the calculation of these numbers beyond a half amplitude, since they must be symmetrical on each side of the vertical, when the values of the time t are reckoned, as they always can be, from the extremity of the half oscillation in which the pendulum actually is. This being understood, the use of the table is easily explained; for the immediate observation gives the demi-amplitude α at the period of the comparison with the chronometer; it gives also, at this instant, the value of the arc ε, according to the division on the scale of amplitudes to which the stem of the pendulum corresponds. Dividing ε by α, the decimal fraction which will hence result, being multiplied by the number 1000, may be compared with the numbers contained in the second column of the above table; and the first column will immediately give, either directly or by interpolation, the fraction of time corresponding to this position of the stem, a fraction which must be added to the whole number N of the preceding oscillations if the pendulum is on its descent towards the vertical, and subtracted from N + 1 if the pendulum is on its ascent towards the end of the oscillation.

The experiments on the variation of gravity at different places on the earth were not at first made with a free pendulum such as we have now described, but with a pendulum adapted to a clock. It was in this manner that Richer discovered the existence of this phenomenon in 1672, in a voyage which he made to Cayenne by order of the Academy of Sciences, for the prosecution of various researches in physics and astronomy, among the number of which was the measurement of the pendulum. On his arrival at Cayenne, Richer remarked that his clock, the weights of which had not been altered since his departure, had a diurnal rate of going of 2′ 28″ slower than at Paris; and not only did this observation prove the fact of the diminution of gravity, in going from the pole towards the equator, but, if we had known the details, particularly in regard to the relative differences of temperature, we might then probably deduce a more certain and exact measure of this diminution than what can be drawn from the absolute length of the equatorial pendulum, determined by the same Richer at Cayenne, with the imperfect methods which were then in use. We shall not dissemble that this assertion requires some proof; for the mode of observing by clocks appears necessarily subject to great uncertainty, the pendulum's own motion being constrained or modified by the motion of the wheels. But this influence is not, perhaps, in reality so great as one would be led to suppose; in fact, it is not the pendulum, but the weight applied to the clock, which makes the wheels move; the pendulum merely regulates the intermittances in the fall of this weight, by its oscillations, which stop it and set it free by turns; and this alternation is performed by means of the escapement, which now disengages itself from the teeth, and then lays hold of them again. When it is disengaged, the action of the weight which turns the wheel excites it, and accelerates its fall it its descent. But in the ascending half oscillation which follows, the same action confines the pendulum and retards it; so that these two contrary efforts, which both operate with very slight degrees of friction, appear, like the resistance of the air, and every other constant friction, to balance their mutual influences on the motion in each whole oscillation, and merely to limit the amplitude of the arcs in which this oscillation takes place; a limitation which we can easily take into account, by observing the amplitudes, and reducing all the oscillations, by calculation, to the case of their being infinitely small. It would be curious to make experiments on this subject, and it could be easily done; for it would be sufficient to vary the weight applied to a clock, and to see if the variations of amplitude which would result are such that, in paying attention to them, the clock may be brought back to its original rate. Some observations already made indicate the exactness of this restitution, or at least the very near approach to it.

In the travels in Lapland, for example, undertaken by the French academicians in 1736, an excellent clock by Graham was carried out to be employed in determining the variation of gravity. This celebrated artist had constructed it for this purpose, and had done so with very particular care. In order to render it more steadily comparable with itself, he had adapted to it a pendulum, formed of a simple rod of brass, to the bottom of which was affixed a lenticular mass of a constant weight; and he had provided pieces which raised the rod up during the voyage, and kept its summit free from all contact, so that the knife edge could not be altered by any friction against the plane of suspension, although the rod was always at liberty to follow the dilatations and contractions produced by the changes of temperature. Now, in the account of the labours connected with this operation, which Maupertuis has published, under the title of *Figure de la Terre Determinée*, we find, that with the action of the weight usually applied to this clock, it made, at Paris, 86394″·4, during a revolution of the fixed stars, in describing arcs of 2° 10′ on each side of the vertical, while, with a weight twice as small, it made 4″ more, that is, 86398″·4 in the same interval, describing arcs of 1° 15′. Now, if we apply here the correction relative to the amplitude of the arcs, which is

$$\frac{1}{16} \text{N} \sin.^2 \alpha,$$ calling N the number of oscillations, and α the demi-amplitude, we shall then find, that in the first case it is necessary to add 7″·711 oscillations, and in the second 2″·563, to reduce each of them to the case of amplitudes infinitely small, which gives 86402·1 and 86401·0 for the total number of oscillations infinitely small in the two cases. These quantities only differ by 1·1, and as the observations at this period were not carried to a greater exactness than this difference, it would be of no use to look for a more perfect agreement between them. We have still the example of a similar proof made by Graham himself, upon another clock, which he had constructed to determine the variation of gravity between London and Jamaica; an object for which it was really employed, its rate having been observed for this purpose by Graham in London, and at Jamaica by C. Campbell, a skilful observer, and the friend of Bradley. In the account of this operation, which has been given by Bradley himself, in No. 431 of the Philosophical Transactions, it appears that Graham having taken away the weight from this clock, which was 12lb. 10½oz., and having replaced it by another of 6lb. 3oz., the amplitudes of the oscillations, which were at first 3° 30′, were reduced to 3°, and the diurnal rate of the clock slackened by 1½″. Now, if we reduce each of these rates to the case of amplitudes infinitely small, in taking successively for α, 1° 45′ and 1° 15′, we find for the reduction in the first case 5″·03, in the second 2″·6, of which the difference is 2″·4, instead of 1″, which Graham had observed; and as this able artist had not had any other end in view than to prove the small alteration in the diurnal motion by a change of weight so considerable, it is possible that he may not have taken the same pains in determining the temperature and other details of the observation, which he would have done if he had been seeking to determine an element of correction with a perfect accuracy. It appears very probable, then, by these examples, that in clocks constructed in this manner, the action of the weight, transmitted by the wheels, accelerates the proper motion of the pendulum, during each descending half oscillation, as much nearly as it retards it in the ascending half oscillation which follows. So that these opposite modifications seem to compensate each other, at least with a sensible equality, in each complete oscillation. Whence we may conclude, with equal probability, that the greater or less facility in the motions, and the various energies of friction produced by the unequal tenacity of the oil, at different periods and at different temperatures, can have but a very small influence on the proper motion of a pendulum, and which must become quite insensible by employing an oil of tried permanence of constitution; and, above all, by producing artificially, at all the stations, the same fixed temperature as was done by the French academicians in 1736, in their journeys in Lapland, and also by the intrepid English mariners in 1820 in their memorable voyage to the North Pole. But admitting the constancy of the results obtained at the same place by this mode of observation, which, we repeat, still wants to be completely proved by new experiments, it is clear that no other method could be more convenient. For it would be sufficient in every place to prepare the clock; to set it up, with every precaution in levelling which can place it in a state and situation similar to itself; then to compare its rate of going with the diurnal motion of the heavens, either with a small transit instrument, or even by means of a simple telescope, firmly fixed to some immoveable mass, and directed towards a star, the diurnal return of which could be observed with fixed wires stretched in the focus. MM. Breguet instituted a series of experiments on this subject; but as the processes for determining results of this nature cannot be too severely scrutinized, we sincerely wish that other observers would make similar attempts, and publish the results deducible from them.

USE OF THE PENDULUM IN DETERMINING THE OBLATENESS OF THE EARTH, AND THE INTENSITY OF GRAVITY AT DIFFERENT LATITUDES.

According to the theory of universal attraction, if we consider the earth and the planets as having been originally masses in a fluid state, endowed with a motion of rotation round themselves, they must have taken the form of a spheroid, flattened at its poles; and the force of gravity, which is observed at their surfaces, would then be the result of two distinct forces, of which the one is the general attraction, exerted upon each point of the surface by all the particles of matter in the spheroid, according to their masses and distances; and the other is the centrifugal force, excited at the same point by the motion of rotation. But the intensity of the attraction, exerted upon different points of the surface by the whole mass, must be in general variable, as well as the centrifugal force. The union of these two causes, then, must produce in the force of gravity inequalities, which observation may discover. But we may easily rid these inequalities of the effect of the centrifugal force; for this can be calculated for each point, when we know the dimensions of the spheroid, its rotation, and the axis round which it turns. The observations thus reduced present results which are only dependent on the attraction of the spheroid upon which they are made; and they may consequently serve to determine its exterior configuration, as well as the laws of density, by which the attractive matter is distributed through its interior. The remarkable discovery of these relations, between the force of gravity at the surface of the heavenly bodies, and their form, as well as their internal constitution, we owe to Newton; and this great man, in following them out, determined even the value of the oblateness which the terrestrial spheroid ought to have, supposing it elliptical and homogeneous, in order to be in equilibrio with the actual velocity of its rotation. He thus found, that denoting by φ the observed ratio of the centrifugal force to the force of gravity at the equator, the oblateness of the spheroid must be $\frac{5}{4}\varphi$; and as φ, from observation, may be estimated for the earth at $\frac{1}{289}$, or at 0·00346031, there results the oblateness $\frac{5}{4}\varphi = \frac{1}{231}$, or 0·004325, a quantity much superior to the observed value, 0·00326, which shows that the terrestrial spheroid is not homogeneous. But, as this element of measure had not as yet been determined in the time of Newton, he could not draw this consequence. He confined himself, therefore, to the determination of the variations of gravity in the case of the supposed homogeneity, and he found it, as it is in fact, proportional to the square of the sine of the latitude. But he erred in endeavouring to extend these determinations to the case of any ellipsoid, composed of concentric strata of unequal density. For, finding that the observations of the pendulum gave the actual variation of gravity in proceeding from the equator to the pole, greater than the calculation established for the case of homogeneity, he thought that the oblateness ought to increase at the same time with this variation, although the real measures of degrees have since pointed out the inverse of this result; for they agreed in giving a slighter oblateness than 0·004325, with a more considerable variation of gravity. Clairault, in his admirable work on the figure of the earth, was the first to point out this error, which had escaped Newton; and he demonstrated at the same time this remarkable theorem, that, in all the hypotheses, the most probable that can be formed regarding the density of the interior parts of the earth, which must always be supposed most dense towards the centre, there is always such a connection between the fraction which expresses the difference of the axes, and that which expresses the diminution of gravity from the pole to the equator, that, if the one of these two fractions exceeds 0·004325, the second will fall short of it by the same quantity; so that their sum must be always equal to the double of 0·004325, or to 0·00865. In this case, also, the length of the seconds pendulum varies from the equator to the pole, in proportion to the square of the sine of the latitude. Thus, calling λ this length at any latitude L, and A the length at the equator itself, we have in general $\lambda = A + B \sin.^2 L$, B being a constant co-efficient, to be determined by observation. It must be remarked, however, that this result supposes the lengths of the pendulum to be observed at the very surface of the terrestrial spheroid; for, in receding from this surface, although at the same latitude, the intensity of gravity diminishes nearly in proportion to the square of the distance from the centre, and consequently the length of the pendulum must diminish according to the same law. Reciprocally, then, if we have observed this length at any height h above the terrestrial surface, and that we have found for it a value expressed by l, a being the radius of the earth at this latitude, the length reduced to the level of the sea will be $\frac{l\,(a+h)^2}{a^2}$, or $l + \frac{2hl}{a} + \frac{lh^2}{a^2}$. But this reduction may be simplified, by considering that, on account of the small height to which we can rise above the earth's surface, $\frac{h}{a}$ is always a fraction so excessively small, that the first power of it is sufficient to be used. So that, limiting ourselves to this order of approximation, the reduced length will become $l + \frac{2hl}{a}$. The term $\frac{2hl}{a}$ forms, then, the correction which the experiments require that they may be reduced to the level of the sea, and thus rendered comparable with each other. Such is, in fact, the mode of reduction generally employed; but we must remark, that it is itself subject to uncertainty. For the mountains on which we ascend attract the pendulum by virtue of their own mass; in consequence of which, it becomes necessary to pay attention to this attraction, that the reductions may be made rigorously exact, instead of applying the bare formula, which supposes the observations to have been made in the open atmosphere. But this is an inconvenience which is unavoidable; for it is impossible to calculate exactly the peculiar attraction of the masses on which we operate, since this would require the knowledge of their relative density, and even of the arrangement of the materials which enter into their composition. But, as we cannot avoid this uncertainty, we must endeavour to render it as small as possible, by making our observations as near the level of the sea as we are able. We must then recollect, that, by ascribing at the highest station the whole of the force of gravity to the sole and distant action of the earth, we suppose it to be more powerful than it really is. So that, by reducing it, on this hypothesis, to what it would really be if it had been observed at the level of the sea itself, we commit a double error; the mountain's own attraction tending, in this second case, by its contrary direction, to weaken the effect of gravity, which it had before augmented. Fortunately, the excessive smallness of the highest mountains, compared with the mass of the globe, must diminish extremely their relative influence, and render equally minute the errors which may arise from neglecting it.

To determine, now, the co-efficients A and B of the general formula, we shall employ the oblateness 0·00326, or $\frac{1}{306{\cdot}75}$, which M. Laplace has obtained by submitting to a general and profound discussion the measures of the terrestrial degrees, and the lunar inequalities depending on the oblateness of the earth. We shall join to it the length of the simple pendulum of sexagesimal seconds, found by Biot at the station of Unst, a length which, we think, may be considered as one of the most certain that has been observed; first, because having been the last of the observations made by Borda's method, it must have been taken with all the precautions suggested by preceding experiments; secondly, on account of the great number of series from which it results, these being fifty-six in number, and made with different rules, and pendulums of unequal lengths, which all agreed in assigning for the definitive result values differing excessively little from each other; and, lastly, from the perfect agreement which is found between it and the results of the observations of Captain Kater. This single absolute length, together with the oblateness 0·00326, will suffice for determining the two constant quantities A and B of the general formula, which expresses the length of the pendulum at any latitude. Now, according to this formula, the length of the pendulum at the equator, where L is nothing, is equal to A, and at the pole, where L = 90°, it is $A + B$. So that $\frac{B}{A}$ is the relation of the total variation of the pendulum to its absolute length at the equator; a ratio which is the same as that of the increments of gravity to the absolute force of gravity itself. Adding, then, $\frac{B}{A}$ to the oblateness 0·00326, we shall have, by the theorem of Clairault, the following condition, $\frac{B}{A} + 0{\cdot}00326 = 0{\cdot}00865$, whence we obtain $B = A \cdot 0{\cdot}00539$, and consequently $\lambda = A\,(1 + 0{\cdot}00539 \cdot \sin.^2 L)$. Now we have seen above, that at the station of Unst, in latitude 60° 45′ 25″, the length of the sexagesimal seconds pendulum determined by the observations of Biot was $\overset{m\,m}{994}{\cdot}943105$. The height of this station was only 9^{m} above the level of the sea, which gives for the reduction $+\,0{\cdot}^{mm}002818$. Whence there results, at the level of the sea, the height $\overset{m\,m}{994}{\cdot}945923$. Putting this value, then, and that of L in the formula, the co-efficient A is determined, and we find $A = \overset{m\,m}{990}{\cdot}879660$, consequently $B = 5{\cdot}340843$; which gives for any latitude L,

$$\lambda = \overset{m\,m}{990}{\cdot}879660 + \overset{m\,m}{5}{\cdot}340841 \sin^2 L.$$

If we wish to reduce this formula to English inches, all the terms must be multiplied by $\frac{39{\cdot}37079}{1000}$, and then

$$\lambda = \overset{in.}{39}{\cdot}0117150 + \overset{in.}{0}{\cdot}2102732 \sin.^2 L.$$

Finally, if we wish to reduce it to the decimal pendulum employed by the French observers in their calculations, we must multiply the terms by $\left(\frac{864}{1000}\right)^2$, the ratio of the decimal to the sexagesimal pendulum. We then have

$$\lambda = \overset{m\,m}{739}{\cdot}687686 + \overset{m\,m}{3}{\cdot}986917 \sin.^2 L.$$

If we calculate from this last formula the lengths of the decimal pendulum for the stations where the French observers have operated, from Formentera to Unst, and compare them with their results, we obtain the following table.

Names of the Places.	Names of the Observers.	North Latitudes.			Length of the Decimal Pendulum at the Level of the Sea.		Excess of Calculation.
					By Calculation.	By Observation.	
					mm	mm	
Unst	Biot.	60°	45′	25″	742·723136	742·723136	0·000000
Leith Fort	Biot, Mudge.	55	58	37	742·426416	742·413435	+0·012981
Dunkirk	Biot, Mathieu.	51	2	10	742·098066	742·077030	+0·021036
Paris	Biot, Mathieu, Bouvard.	48	50	14	741·947360	741·917490	+0·029870
Clermont	Biot, Mathieu.	45	46	48	741·735412	741·705180	+0·030232
Bordeaux	Biot, Mathieu.	44	50	26	741·670048	741·608720	+0·061328
Figeac	Biot, Mathieu.	44	36	45	741·654181	741·612280	+0·041901
Formentera	Biot, Arago, Chaix.	38	39	56	741·243950	741·252000	—0·008050

The progression of the deviations contained in the last column of this table shows, in proceeding from the north to the south, a progressive decrease of gravity, greater in a slight degree than the elliptical figure requires; a result which had already been remarked in regard to Scotland and England by Captain Kater. It may be observed here, that the absolute value of this variation for Unst, Leith, and Dunkirk, agrees exactly with that which Captain Kater has found, or what could be deduced from his experiments. But the same effect is observed to continue throughout France, being most sensible at the station of Bordeaux. It becomes less even at Figeac, situated more inland, and on a more solid base. It again becomes nothing at Formentera, where the deviation of the formula compared with observation is $\frac{8^{mm}}{1000}$ in a contrary direction, which would seem rather to indicate a slight local excess in the intensity of gravity. This singular anomaly, which is so stated, in regard to the force of gravity, throughout the terrestrial arc which extends over all this part of Europe, is, without doubt, owing to peculiarities in the geological constitution of the countries which are situate on it; and it appears by this example, how well the observations of the pendulum are adapted for pointing out the irregularities of this constitution. But, for this purpose, the observations must possess so great a degree of exactness that the peculiar uncertainties to which they are liable may be, as we may suppose they were in those which we have employed, much smaller than the variations of constitution which they are intended to indicate. Here it may be remarked, that the part of France where these variations are the most sensible, are precisely the same where there were found, by Delambre's observations, the greatest anomalies in the lengths of the degrees.

From the preceding formulæ may be deduced the variation in the diurnal rate which a compound pendulum, of an invariable form, must present when carried to different latitudes. If we denote by N, N the number of oscillations of this pendulum at two different stations, where the lengths of the simple seconds pendulum are λ, λ′, we have shown above that $\frac{\lambda'}{\lambda}\ \frac{N'^2}{N^2}$, whence $N'^2 = \frac{\lambda'}{\lambda} . N^2$. Now, calling L, L′ the latitudes of the two stations, the above formulæ give the values of λ and of λ′, as well as their relations; substituting, then, these values in the preceding equation, we obtain $N'^2 = \frac{A + B \sin.^2 L'}{A + B \sin.^2 L} N^2$; an expression by means of which we can calculate N′ when we know N.

The total variation of gravity from the equator to the pole is so inconsiderable that the difference between the numbers N, N′ is always very small compared with these numbers themselves. This difference, then, is the element which we must try to put in evidence in the formulæ. But nothing is easier; for, if we denote it by *n*, so that N′ is represented by N + *n*, the preceding equation will become

$$N^2 + 2nN + n^2 = \frac{A + B \sin.^2 L'}{A + B \sin.^2 L} . N^2.$$

Whence we deduce

$$2nN + n^2 = \frac{B \sin. (L' + L) \sin. (L' - L)}{A + B \sin.^2 L} . N^2;$$

and resolving the value of N into a series,

$$n = \left\{ \begin{array}{l} \frac{B \sin. (L' + L) \sin. (L' - L)}{2 (A + B \sin.^2 L)} . N \\ - \frac{B^2 \sin.^2 (L' + L) \sin.^2 (L' - L)}{8 (A + B \sin.^2 L)^2} . N, \&c. \end{array} \right\}$$

But from the value of the oblateness which we have adopted, we have seen that B is equal to 0·00539 A. Substituting this value in our series, it becomes

$$n = \left\{ \begin{array}{l} \frac{0{\cdot}00539\ N \sin. (L' + L) \sin. (L' - L)}{2 (1 + 0{\cdot}00539 \sin.^2 L)} \\ - \frac{0{\cdot}000029\ N \sin.^2 (L' + L) \sin.^2 (L' - L)}{8 (1 + 0{\cdot}00539 \sin.^2 L)^2}, \&c. \end{array} \right\}$$

The second term will be almost always insensible, and it will be quite needless to take in any of the following ones.

To show the use of this formula, we shall apply it to the following observations, which belong to the most distant countries on the earth.

Names of the Observers.	Names of the Stations.	Longitudes, reckoned from Greenwich.	Latitudes	Number of Oscillations performed by the Compound Pendulum in a Sidereal Day, or in a mean Solar Day, at the same Temperature.	Variation of the Diurnal Rate, by Observation.	Variation of the Diurnal Rate, by Calculation.	Difference.
G. Graham & C. Campbell, in 1731 and 1732	Jamaica	76° 45′ 15″ W.	18° 0′ 0″ N.	86283·0	118″·2	119″·96	—1″·76
	London	0 0 0	51 31 0 N.	86401·2			
Maupertuis, Clairault, Lemonnier, 1738	Paris	2 20 15 E.	48 50 14 N.	86394·4			
	Pello		66 48 0 N.	86453·5	59 ·1	64 ·70	—5 ·60
Graham, 1738	London	0 0 0	51 31 0 N.	86402·1	51 ·4	53 ·85	—2 ·45
Freycinet	Paris	2 20 15 E.	48 50 14 N.	89143·8			
	Rio Janeiro	43 18 37 W.	22 55 2 S.	89048·8	95 ·0	99 ·43	—4 ·43
	Cape of Good Hope	18 24 0 E.	33 55 15 S.	89086·4	57 ·4	61 ·10	—3 ·70
Sabine, 1818	London	0 0 0	51 31 8 N.	86497·40			
	Brassay		60 9 42 N.	86530·51	33 ·11	31 ·82	+1 ·29
	Hare Island		70 26 17 N.	86562·64	65 ·24	62 ·46	+2 ·78
Sabine, 1820	London	0 0 0	51 31 8 N.	86455·65			
	Melville Island	110 49 0 W.	74 47 14 N.	86530·38	74 ·73	73 ·93	+0 ·80

The experiments of Captain Sabine were made with two pendulums applied to two different clocks, the results of which have agreed very well in their relations. We have only stated here the mean of these results. The observations of Maupertuis, Clairault, and Lemonnier, were made by a process of the same kind, but with a single clock by Graham. In these two expeditions the observers produced artificially at the second station the same temperature as at the first. In the operation by Campbell, the same pains were not taken; but in Bradley's computations, an allowance was made according to the indications of the thermometers. The experiments of Captain Freycinet were made on detached pendulums, the rate of which, first determined by Arago, Mathieu, and himself, at the Royal Observatory of Paris, was compared in the voyage with well-regulated chronometers, making allowance, by calculation, for the changes of temperature. The smallness and the irregularity of the differences which are found between the results of these different experiments, and the numbers given by the formula, show that the latter is the general expression of them, modified only by the accidental variations which may be occasioned in each place by small differences of density in the neighbouring strata of the surface of the earth. The formula being grounded upon the oblateness 0·00326, or $\frac{1}{306{\cdot}75}$, its agreement with the facts proves that this value of the oblateness, if not rigorously exact, is at least a very near approximation, and is, besides, common to the two hemispheres of the globe, since the observations of Captain Freycinet in the southern hemisphere, at the Cape of Good Hope, are as correctly represented by it as the observations made in the northern hemisphere. This puts an end, then, to the notion entertained after the measurement of the degree by Lacaille in this part of the globe, that the southern hemisphere was more oblate than the northern; a notion, however, already much weakened by the agreement of the oblateness observed in this latter hemisphere, with that which was deduced from the inequalities of the moon; since the motion of this satellite must be influenced by the mean of the two ellipticities, if they were different; but it was nevertheless of consequence to see this suspicion wholly extinguished, as it is now by Freycinet's observations.

The general experiments on the length of the pendulum which we have above described, being verified by the different observations by which we have compared them, will serve to determine the intensity of gravity, whether absolute or relative, on any of the places of the terrestrial globe. For, calling λ the length of the simple pendulum, which makes its oscillations in a second of time in a given place, and denoting by g the double of the space which gravity makes bodies describe in their fall in the same place, and during the same interval of a second, the fundamental formula of oscillations, infinitely small, gives $1'' = \pi\sqrt{\frac{\lambda}{g}}$, consequently $g = \pi^2\lambda$, π being the ratio of the circumference to the diameter, or 3·14159. But we have already given for any latitude the value of λ expressed in millimetres and in English inches, taking for the unity of time either the decimal or the sexagesimal second. Multiplying these expressions by the square of π, we shall have the value of g for the same latitude, and the same kind of unity of time which may be chosen.

It may be objected, that we have not made use of the lengths of the simple pendulum observed under the equator by Bouguer, and detailed in his work on the figure of the earth. The reason is, that, notwithstanding the ability of Bouguer as a philosopher and an observer, and the infinite pains which he took in his measurements of the pendulum, it appears to us, on account of the nature of the processes he made use of, that they are too inexact to be employed with advantage. The method of Bouguer consisted in forming a sort of simple pendulum, with a very small weight suspended to a stem, the other extremity of which was attached to a pincer fixed into a solid wall. He made this little pendulum always of the same length, by comparing it with an iron rule, which served him for a standard; after which he determined the value of its oscillations by comparing its rate with that of a clock regulated by the heavens. But M. Laplace has justly remarked, that the bending of the stem at the point of suspension, where it is inserted into the pincer, must produce the same effect on the oscillations as a contraction in the wire; so that the length, measured in a state of repose, must be too great, and would appear to give the pendulum too long. This effect, indeed, must have been produced on all the lengths given by Bouguer, since they were all observed in the same manner. From that it would seem that these observations might at least be employed in comparison with each other, and in that case give exact ratios. But the process by which Bouguer judged of the length of his little pendulum, and compared it with his standard rule, appears to us not accurate enough for giving a sufficient certainty in his results. For it consisted in laying this rule close to the pendulum, placing its upper end in contact with the point, and judging of its equality by the eye, in comparing it with the pendulum at its lower extremity. But no one, by such an operation, can answer for an exactness greater than $\frac{5}{100}$ths of a line. Now $\frac{5}{100}$ths of a line being equal to $\frac{1}{10}$th of a millimetre, such an error, with the methods now actually employed, would be accounted gross, and such indeed as, with the least attention, it is quite impossible to commit. These results cannot, then, be compared with the observations which are made now; and, unfortunately, the same remark applies with equal justice to the measurements of the absolute lengths of the pendulum which were made about the same period, as well in France as in various other parts of the globe. We think it extremely probable, that to the want of exactness in the methods employed at that time may be ascribed, at least in a great measure, the strange anomalies observed by Grischow in the lengths of the pendulum, in the neighbourhood of St Petersburg, between stations very little distant from each other; anomalies so much more justly suspected, since the different instruments employed by Grischow to establish them are far from agreeing with each other. Nevertheless, for removing entirely all suspicion with regard to a point so important, it would be a useful undertaking to repeat these experiments in the same places where Grischow's observations were made; employing for this purpose our present much more accurate methods. (S. S. S. S.)

Much has been done in this department of science since the preceding part of this article, which was written by M. Biot for the Supplement to the sixth edition of this work, was published. This took place not long after a most important addition had been made both to the instruments of research and to the methods of experimenting, by the invention, or at least the construction and application, of the convertible pendulum.

IV.—DETACHED PENDULUMS.

Although Professor Bohnenberger, in a treatise on astronomy, published at Tübingen in the year 1811, had suggested that the length of the seconds pendulum might be obtained by means of Huygens's theorem, yet he seems to have done nothing towards putting the scheme in practice; nor had any notice of such a suggestion reached Captain Kater till fully eight years after he had devised and executed his valuable experiments, as described in the Philosophical Transactions for 1818. These form a new era in the history of the pendulum, and have greatly increased the interest and importance which, only a few years before, had begun to be attached to researches on this subject, and which have ever since continued to increase. This is evinced, not only by the repeated and valuable labours of several of the most distinguished mathematicians and experimentalists of the present age, but also by the numerous scientific voyages that have been undertaken by various governments, with the view of ascertaining and comparing the results of different pendulum experiments made in various parts of the world, and thence to determine the true figure of the earth. The most valuable and extensive experiments of this sort are those made by Major Sabine and those by the late Captain Henry Foster, in almost every practicable latitude, and embracing a greater variety and range of temperature than those of any other experimentalist. As is the usual method among the English experimenters, invariable pendulums, which had been first observed in London to ascertain the number of vibrations made there per day, were afterwards observed in the same manner at all the stations, and similarly again on returning to London. In this manner, without regarding the absolute force of gravity at any one place, the proportion of it at different places is found probably with greater accuracy than by any other method. With the French philosophers, however, it is more usual to observe the absolute length of the seconds pendulum at every station. In this manner they have experimented in a great variety of places; but in some cases they have also employed invariable pendulums, which are the same with those called "pendulums of comparison" in the preceding article; for the term *invariable* does not refer to any compensation for temperature, &c., but merely implies that the effective length is never interfered with, by shifting or altering the positions or magnitudes of any of the parts. In this way the results at different stations are more capable of being compared.

It is not many years since such results, especially the number of vibrations which are made in a mean solar day, whether by the same or by different pendulums, were considered as strictly comparable with each other, provided only they were reduced, by means of certain hypothetical rules, to what it was believed they should have been under the following circumstances: 1*st*, at the mean level of the sea; 2*d*, in a vacuum; 3*d*, in indefinitely small arcs; and, 4*th*, at a common standard of temperature.

The late Dr Thomas Young, however, at length demonstrated that the formerly-received formula for the reduction to the level of the sea is in most cases too great. M. Bessel next questioned the old formula for the reduction to a vacuum, as having the contrary fault of being too small. This he had inferred from some very far-fetched experiments; but that the old correction was really too small, has since been amply confirmed by the direct experiments of Major Sabine and Mr Baily. In this reduction to a vacuum they had all to a certain extent been anticipated by the Chevalier Du Buat, who has treated the question experimentally, and at great length, though in a much less satisfactory manner, in his *Principes d'Hydraulique*, second edition, 1786, and third edition, 1816. But his researches having appeared before any great interest had been taken in this question, they were till lately almost totally overlooked and unknown. The like may be said of some hints given by Newton, and well deserving of notice, in his *Principia*, lib. ii. prop. 27, cor. 2. Fortunately, this defect in the old formula for the reduction to a vacuum has not been productive of any considerable errors in the determinations of the proportions of the force of gravity at different places. In the Philosophical Transactions for 1831, Major Sabine has described a variety of experiments, which have led him to question the accuracy of the usual formula for the reduction to indefinitely small arcs. He had previously, in his work on the figure of the earth, pointed out the discordant results arising from the use of different agate planes with the same knife-edge; and had also stated his decided opinion on the powerful effects of certain geological strata, or even of an increase of buildings, in the immediate neighbourhood of the pendulum. Mr Baily, again, in the Philosophical Transactions for 1832, has gone much farther, in having pointed out great discordances between experiments executed with the *same* knife-edge of the *same* pendulum, and on the *same* plane. He likewise acknowledges, that to whatever cause the observed anomalies may be owing, he has, during a long course of experiments on various pendulums, at different seasons of the year, and under a variety of circumstances, frequently met with discordances that have baffled every attempt at explanation by any of the known laws applicable to the subject; and other persons, also, who have had much practice in such experiments, have occasionally met with anomalies for which they have been as unable to account. As it is desirable, however, that these difficulties should be cleared up, if possible, and as every information connected with so important a subject, founded on such delicate experiments, must add to our means of removing them, we shall by and by give a summary account of the results of a variety of experiments made by Major Sabine and Mr Baily, with pendulums of various forms and constructions, immediately bearing on the discordances in question.

It is evident that till two pendulums can be constructed which will always give precisely the same results, cleared of all these discordances, the important problem of determining the length of the simple pendulum cannot be considered as fully solved; neither can the observations made by different experimentalists, in different parts of the globe, with different pendulums, be strictly and directly comparable with each other. We have, it is true, two pendulums, differing widely in form and construction, and yet agreeing surprisingly in their results, viz. Borda's and Kater's. But although this evinces the talent and skill of the distinguished persons who made the experiments, it should not be forgotten that the reductions to a vacuum were, in both cases, made agreeably to the old formula; and that since the date of M. Bessel's important researches on this subject, which indicate the necessity of revising the computations of all preceding experiments, no rigid comparison of the results has yet been repeated. The amount of the additional corrections for Borda's pendulum and for that of Kater differ materially, as will be shown in the sequel, so that we are as yet ignorant whether the results of any two pendulums that have ever been differently constructed are in strict accordance with each other; nor, until this is practically accomplished and repeated, can the true length of the seconds pendulum be considered as satisfactorily determined.

eduction
o the level
f the sea.

It had long been the practice to make allowance for the height of any station above the level of the sea, without taking into account the attraction of the elevated parts themselves. Dr Young showed that this was far from being correct; but no one has yet been able to estimate the exact amount of the error, nor is it likely ever to be attained. It is, however, obvious, that if we were raised on a sphere of earth a mile in diameter, its attraction would be about $\frac{1}{8000}$ of that of the whole globe; and instead of a reduction of $\frac{1}{2000}$ in the force of gravity, we should obtain only $\frac{3}{8000}$, or three fourths as much. Nor is it at all probable that the attraction of any hill a mile in height would be so small as this, even supposing it to have been only two thirds the mean density of the earth. That of a hemispherical hill of the same height would be fully one half more than the sphere, or would exceed its attraction in the ratio of 1·586 to 1. And it may be easily shown that the attraction of a large tract of table-land, considered as an extensive flat stratum a mile in thickness, would be three times that of a sphere a mile in diameter, or about twice as great as that of such a sphere having the mean density of the earth; so that for a place so situated the allowance for elevation would be reduced to one half; and, in almost any country that could be chosen for the experiment, it must remain less than three fourths of the whole correction deduced immediately from the reciprocals of the squares of the distances from the earth's centre. From Dr Young's view of the subject, it also appears that the correction for the elevation above the sea will vary, according to the nature of the eminence, and also its density, from one half to three fourths of the quantity which it was customary to deduce from the inverse ratio of the squares of the distances from the earth's centre. Thus, if the mean density of the earth be taken at 5·5, and that of the matter surrounding the station at 2·5, the quantity deduced from the duplicate distances should be multiplied by $\frac{66}{100}$ to obtain the correction for a table-land, and by $\frac{7}{10}$ for that of an eminence of moderate declivity. (Philosophical Transactions for 1819.)

Perhaps some estimate might be formed of the local effects of a cavity, or of a circumscribed mass of any peculiar density, and hid under the surface, by swinging the pendulum at several places around the principal station, and not far from it; and it might even throw some light on the subject to swing the pendulum both in the plane of the meridian and at right angles to it.

In 1824 a series of pendulum experiments was made by Carlini at the summit of Mont Cenis, to ascertain the diminution of gravity at the height of a geographical mile, as detailed in the Milan Ephemeris. He obtained for the mean density of the earth 4·39; but the changes which experiment has shown to be necessary on the elements of reduction throw some doubt on its value. Mont Cenis is peculiarly favourable for such experiments, as it forms nearly a segment of a sphere, of which the chord is about eleven geographical miles, and the versed sine one mile. It consists of calcareous rocks whose mean density is 2·66. The mountain Schehallien, on the attraction of which Maskelyne and Hutton made experiments, has since then undergone a mineralogical survey; and from the more correct data so obtained some alteration has been made on the original numerical results. The calculations of Cavendish's experiments on attraction were also corrected by the late Dr C. Hutton, as detailed in the Philosophical Magazine for July 1821. Professor Reich of Freyberg has recently repeated Cavendish's experiment, though in some respects on a smaller scale; for the larger leaden sphere was only 7·75 inches in diameter, and he used only one such sphere at a time. The result gave 5·44 for the mean density of the earth, and an iron ball of the same size gave 5·43. Cavendish's experiment is also about to be repeated in this country, and a new proposal will be noticed afterwards.

Reduction
to a vacuum.

Newton and Du Buat had, as already mentioned, made it plain that the air affects in several ways the motions of pendulums; and more recently M. Bessel has called attention to the subject by his very interesting work on the pendulum,[1] in which he has shown that the usual formula for the reduction to a vacuum, as far as the specific gravity of the moving body is concerned, is very defective, and by no means expresses the whole of the correction which ought to be applied; in fact, that a quantity of *air* is also set in motion by and adheres to the pendulum (varying according to its form and construction), and thus a *compound pendulum* is in all cases produced, the specific gravity of which will be much less than that of the metal itself. He observes, that if we denote by m the mass of a body moving through a fluid, and by m' the mass of the fluid displaced thereby, the accelerating force acting on the body has, since the time of Newton, been considered equal to $\frac{m - m'}{m}$. This formula is founded on the assumption that the moving force which the body undergoes, and which is denoted by $m - m'$, is confined to the mass m. But it must be distributed not only over the moving body, but on all the particles of the fluid set in motion by that body, and consequently the denominator of the expression denoting the accelerating force must necessarily be greater than m. M. Bessel then enters into a mathematical investigation of the principles from which the results of his experiments are deduced, and at length concludes, that a fluid of very small density surrounding a pendulum has no other influence on the duration of the vibrations than that it diminishes its gravity and increases the momentum of inertia. When the increase in the motion of the fluid is proportional to the arc of vibration of the pendulum, this increase of the momentum of inertia is very nearly constant; in all other cases it will depend on the magnitude of that arc.

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[1] *Untersuchungen über die Länge des einfachen Secundenpendels*, 4to, Berlin, 1828.

In the *Mémoires de l'Academie*, tome xi. 1832, and in the *Connaissance des Tems* for 1834, Baron Poisson has endeavoured to investigate the relations between the simultaneous movements of a pendulum and the surrounding air, and has deduced that the loss of weight of a sphere exceeds by one half the weight of air it displaces. Such investigations are, however, unavoidably mixed up with assumptions. The resistance of the air to a ball pendulum has also been considered by M. Plana, in a memoir published at Turin in 1835, in which the case of an incompressible fluid is first discussed, and then that of an elastic fluid; and from both the author concludes, as Poisson had done, that the loss of weight of the sphere exceeds by just one half the weight of the fluid it displaces. The question, however, has not yet received a satisfactory solution, since theory has hitherto failed to account for one of the leading circumstances of the case, viz. that the co-efficient of resistance is different for spheres of different diameters. This difference, it appears, would equally exist whether the balls vibrated in a confined apparatus or in free air. The vibrations of a pendulum in fluid media have likewise been investigated by Mr Green, in the Transactions of the Royal Society of Edinburgh, vol. xiii.

In the theoretical researches on this question, it does not seem to be considered, that since each vibration of a pendulum in air tends to create a current of that fluid, against which it is to return in the succeeding vibration, the alternating motion of the pendulum must subject it to a very different and much greater resistance from the air than if its motion were continuous and not reciprocating. But on what principles a formula could be framed to express the velocity and mass of such currents, or their resistance, we cannot pretend to say. No doubt, if the space in which the pendulum vibrates be very confined, that will farther affect the result. Such considerations seem to set at defiance every attempt at framing any thing beyond an empirical formula for these reductions.

But those experiments and researches, though very imperfect, are sufficient to show that the amount of the correction will not only vary according to the size, figure, weight, and density of the moving body, but also, that in the case of the convertible pendulum (except, perhaps, when it makes the fewest vibrations possible) the correction will not be the same for the two knife-edges, and consequently that a pendulum which has been made convertible in air, will not be so when tried in a vacuum. It becomes, therefore, of importance to know how far the differently constructed pendulums used by various experimentalists are affected by this newly-discovered principle, in order that their results may be strictly comparable with each other. The amount of the required correction, however, cannot in the present state of the question, and most probably never will, be determined by calculation founded on any satisfactory theory, but must for every pendulum be ascertained by actual experiment. The most direct, and perhaps the only certain method of effecting this, appears to be by swinging the pendulum in a vacuum; although M. Bessel himself, on account of some undefinable doubts which he entertained regarding it, adopted two other and very different methods of experimenting for this purpose. The first was by swinging in air one sphere of brass and another of ivory, each being about 2·14 inches in diameter, and suspended by a fine steel wire; the other method consisted in swinging the same brass sphere, first in air and then in water. The results persuaded him that the usual reduction to a vacuum was much too small. The first method, which he considered the preferable one, gave 1·956, and the second 1·625, as the factor by which the old formula should be multiplied, in order to obtain the true correction. To such experiments we can attach very little importance, because these numbers are still reached nearly as much through the medium of a hypothesis as the old formula. What the swinging of a ball in water has to do with the rate of a pendulum in a vacuum, we cannot pretend to see. The experiments of Du Buat were very similar to those of M. Bessel, but if possible still more objectionable.

Old co
rectio

The old correction for reducing the number of vibrations to a vacuum had been deduced from the relative weights of the air and of the pendulum by means of the formula

$$N \times \frac{1}{2\left(\frac{S}{\sigma}-1\right)} \times \frac{\beta'}{\beta} \times \frac{1}{1+(a+\mu)(t'-t)},$$

where N is the number of vibrations in a mean solar day, S the specific gravity of the pendulum, σ the specific gravity of air, μ the expansion of mercury, and a the expansion of air for one degree, β' the height of the barometer, and t' the temperature during the experiments, β and t the standard pressure and temperature for computing the specific gravities. But in this, S ought not, as hitherto, to denote the mean specific gravity, as determined in the usual manner, for the pendulum, when at rest, if it consists of several parts, whose specific gravities are different; for in all such cases we should compute the *vibrating* specific gravity of the mass in the following manner. Let d', d'', d''', &c. denote the distance of the centre of gravity of each body respectively from the axis of suspension (these being positive if below, and negative if above it); w', w'', w''', &c. the weight in the air of each body; s', s'', s''', &c. their specific gravities determined in the usual manner. Then will the required *vibrating* specific gravity of the pendulum be

$$S = \frac{w'd' + w''d'' + w'''d''' +, \&c.}{\frac{w'd'}{s'} + \frac{w''d''}{s''} + \frac{w'''d'''}{s'''} +, \&c.}$$

which is Professor Airy's formula.

The other parts of the above formula forming the old correction are so far erroneous, that no account is taken of the effect of the air set in motion by and accompanying the pendulum, as if adhering thereto; and which is now found to influence the result very materially. Mr Baily thinks, that in the case of the gridiron pendulum, it may be a matter of doubt whether the air between the vertical rods may not diminish their specific gravity, when considered as a vibrating body.

Major
bine's
riment

Early in the year 1828, a proposal was made to the late Board of Longitude, that, on account of the uncertainty in the extent of the defects which M. Bessel had discovered in the old formula for reducing the vibrations of a pendulum in air to what they should be in a vacuum, it would be of great importance to submit the question to the most direct experiment, by the construction of an apparatus in which a pendulum might be alternately vibrated in air of full atmospheric pressure, and in air rarefied nearly to a vacuum. This proposal having been favourably entertained by the Board, orders were given for fitting up an apparatus for this purpose at the public expense, and which was ably executed by Mr Newman, under the direction of Major Sabine, by whom it was to be used; but, that it might also be useful to others who might wish to avail themselves of it for similar purposes, a place was allotted for it in the Royal Observatory at Greenwich. This apparatus, or chamber for forming the vacuum, consists principally of six pieces, exclusive of the iron frame by which the suspension is fixed securely to the wall of the apartment. The pedestal, which has a broad exterior base, is of cast-iron, forming a cylindric dish one foot wide within, and the same in depth; and from a hole in its side proceeds a pipe, which communicates with an air-pump, but can be closed at pleasure by a stop-cock. The three next pieces of the chamber rising in succession above the pedestal are open-ended glass cylinders, each being fifteen inches in depth, and slightly tapering upwards. These and the pedestal have their rims ground to fit upon one another. The suspension-piece, which is the next above the three glasses, is a metal plate, having holes to receive the screws of the bed containing the agate planes, and to admit the pendulum to its place. It is surrounded by a circular metal ring, the outside of which forms a part of the exterior of the apparatus, and the upper and lower surfaces are ground so as to form close joints with the rim of the glass cylinder beneath, and with a bell-glass, which is the sixth piece, closing in the top of the chamber. The ring surrounding the suspension plate is perforated, to admit, through a stuffing-box, a screw, which acts on an inclined plane beneath the Y's, serving to raise the pendulum by means of the Y's, and to lower it again on the planes. The pedestal cylinder is also perforated, to admit, through a stuffing-box, a wire with a cross piece at the extremity, for the purpose of stopping or of giving fresh impulse to the pendulum. A clock was placed about eighteen inches behind the centre of the apparatus, and the coincidences of the two pendulums were observed by means of a telescope about sixteen feet distant. A detached diaphragm, having a vertical opening, the sides of which, viewed from the telescope, were tangents to the disc on the pendulum of the clock, was placed between the apparatus and that disk. The pendulum was first vibrated in air of full pressure, then in rarefied air, and lastly in that of full pressure. A mean being then taken between the two series in the air, was compared with that in the rarefied medium. The result was thus independent of the daily rate of the clock. It was also carefully ascertained, by experiments made on purpose, that, with a free communication between the interior of the apparatus and the external air, the pendulum made just the same number of vibrations as when the glasses were removed altogether.

The following table contains the final results; but for the details we beg to refer to the Philosophical Transactions for 1829, where they are given at great length.

No.	Temperature.	Inches.	Inches.	Vibrations.	Vibrations.	Difference.
1	72°·01	7·08	22·765	7·38	7·42	+·05
2	69 ·70	1·71	27·721	9·065	9·08	+·015
3	35 ·89	2·38	27·459	9·54	9·66	+·12
4	32 ·37	3·59	26·138	9·17	9·26	+·09
5	36 ·40	0·653	29·109	10·38	10·24	—·14
6	35 ·65	14·116	16·080	5·705	5·65	—·055
7	38 ·10	...	30·193	10·525	10·575	+·05
8	41 ·25	...	30·113	10·560	10·48	—·08
Means	45 ·17	...	26·197	9·042	9·046	+·005

The third column is the pressure within the apparatus by the gauge; the fourth the difference between that of the barometer and the third; the fifth the observed retardation, or the difference between the number of vibrations made per day under the full pressure and that in column third; the sixth the retardation by calculation; and the seventh their difference.

In the seventh and eighth experiments, a near approach had been made to a vacuum by repeatedly filling the apparatus with hydrogen, and then exhausting it as far as practicable. At the same time experiments were made on the rate of the pendulum in hydrogen having the full atmospheric pressure, for the purpose of comparing it with the rate in air. From one experiment, it appeared that at the same height of the barometer, 30·193 inches, the pendulum made 8·515 vibrations per day more in hydrogen than in air, the temperature of the gas being 39°·32, and of the air 38°·1. From another experiment it appeared, first, that at nearly equal heights of the barometer (30·120 for hydrogen, and 30·113 for air), the pendulum made 8·56 vibrations more in hydrogen at 39°·75, than in air at 41°·25; second, that it made 1·95 vibration per day more in hydrogen of 0·872 inch pressure, than when the pressure of the gas was 30·120. Hence 1·95 vibration corresponds to a difference of 29·248 inches pressure of hydrogen, and, therefore, two vibrations per day will be the reduction to a vacuum for hydrogen of thirty inches pressure at 40°. The retardation of the pendulum in air is to that in hydrogen as 10·41 to two, and as 10·55 to two, when both are reduced to the same pressure and temperature; the mean being as 5·24 to one nearly. Now, the densities of air and hydrogen being nearly as thirteen to one, shows that the retardation in different elastic fluids is not in the simple ratio of their densities. Major Sabine supposes it to indicate an inherent property in the elastic fluids, analogous to that of viscidity in liquids, of resistance to the motion of bodies passing through them independently of their density.

But perhaps a less hypothetical reason might be given why hydrogen gas should occasion a greater retardation than one thirteenth that of air of full pressure. The retardation of air in these experiments appears to be as its density; thus, for example, air rarefied thirteen times should only offer one thirteenth of the retardation of air of full pressure. Now, it has been shown in the article Hygrometry, vol. xii. page 118, that the specific heat of a given volume of air is as its density; so that air which is thirteen times rarer will emit only one thirteenth as much heat on being compressed. But, from Dr Haycraft's experiments, it appears that, under equal volumes, pressures, and temperatures, hydrogen and air have equal specific heats. Consequently hydrogen of full pressure, on being compressed by the motion of the pendulum, will emit thirteen times more heat than air equally rare would do on being so compressed; and the like may be said of any cold due to the rarefaction occasioned by the motion of the pendulum. Here, it is true, the changes of temperature in the two gases themselves would still be equal, were it not that the materials of the apparatus will have far more power to check any fluctuations or undulations of temperature in the rarefied air than in the hydrogen, which is thirteen times better supplied with sensible heat, and which, therefore, having the equilibrium between the temperatures of its different parts more disturbed by the motions of the pendulum, will be thereby put into a state of greater commotion than the rarefied air, and consequently will so much the more disturb the free motion of the pendulum.

From the mean of the results in the above table we have 9·042 vibrations per day as the reduction to a vacuum of the invariable pendulum vibrating in air of 45° under a pressure of 26·2 inches, and consequently in the same proportion we have 10·36 vibrations under a pressure of thirty inches; but which, if reduced to 32°, by multiplying it by $\frac{448 + 45}{448 + 32}$, as explained below, will be 10·64 vibrations. As we have no information regarding the humidity of the air when Major Sabine made his experiments, we have taken it to be perfectly dry, which it never is. The old "correction for buoyancy," as formerly computed, would have been 6·26 vibrations, which is less than 10·36 in the ratio of one to 1·655, and less than 10·64 in the ratio of one to 1·7.

Now, from the principles developed in the article Hy-

GROMETRY, vol. xii. p. 131, it appears that if the specific gravity of dry air under the pressure P and at the Fahrenheit temperature T be reckoned unit, the specific gravity of a mixture of air and aqueous vapour whose joint pressure is p and temperature t will be

$$\frac{p - \cdot375f}{P} \times \frac{T + 448}{t + 448},$$

where f is the force of the vapour. If, therefore, the reduction to a vacuum, which amounts to 10·36 vibrations when $P = 30$ and $T = 45°$, vary as the density of the medium, it will in all cases be

$$\frac{p - \cdot375f}{30} \times \frac{45 + 448}{t + 448} \times 10\cdot36 = \frac{16p - 6f}{t + 448} \times 10\cdot64.$$

Hence, when $p = 30$ inches and $t = 80°$, the reduction will be diminished about an eightieth part by the presence of aqueous vapour in a state of saturation, for then $f = 1$ inch. However, from the circumstance that hydrogen, compared with air, requires a greater reduction than in the ratio of the density, something of the sort may in a slight degree belong to aqueous vapour. It is farther to be observed, that the constant factor of the above correction applies to the invariable pendulum used by Major Sabine; and that almost every pendulum of a different form or construction will require a different number. A table of these is given on next page.

That part of the difference between the old and new corrections which is occasioned by barometric variations, must be extremely small in all cases of comparison between stations which differ little in their heights above the level of the sea. The specific gravity of an invariable brass pendulum being about 8·4, an inch in the barometer will correspond in buoyancy to about 0·21 of a vibration a day, which, multiplied by 0·65, is about 0·14 vibration. In the comparison of tropical and extratropical stations, the barometer, in the middle and high latitudes, is liable to fluctuate an inch and more from the mean height, which is uniform, or nearly so, within the tropics; but as the observations generally include several days at each station, and as, in proportion to their continuance, the barometer will approximate to its mean height, it will be found that a difference of half an inch in the barometric height at two stations is a rare occurrence. The correction for this is not more than 0·07 of a vibration to be added to the daily number at the station where the barometer was highest. The liability to error from variations of temperature at different stations is, however, far more considerable than from variations of pressure; sufficiently so, indeed, to become in some cases influential on the ellipticity deduced. A difference of 40° of Fahrenheit between the temperatures in the tropics and the high latitudes is by no means unfrequent; and as 16° Fahrenheit are nearly equivalent in their influence on the density of the air to one inch of the barometer, the error in such a case may amount to $0\cdot52 \times 0\cdot65 = 0\cdot34$ of a vibration per day. Moreover, as the difference of temperature is always in favour of the tropical stations, the error will be of a constant nature, unlike the greater part of the small irregularities to which pendulum experiments are liable, and which may compensate themselves by the multiplication of the experiments.

The correction for the expansion or contraction of an invariable pendulum is sometimes derived from pyrometric experiments; but as these are apt to give rather uncertain results, it is more accurate to ascertain, by direct experiments, the difference in the number of vibrations which the pendulum makes in extreme temperatures. This was the method followed by Major Sabine, who found the correction for a brass pendulum to be about 0·44 of a vibration per day for each degree of Fahrenheit; but this depends on the particular materials of which the pendulum is formed.

The experiments of Captain Kater were made, as is well known, in the free air, and its influence in retarding the vibrations, and thereby interfering with the effect of gravity, was only computed and allowed for on the old principle then generally received, but now known to be erroneous. To clear up this point, Major Sabine, at Captain Kater's request, undertook to ascertain, by direct experiment, with the apparatus above described, the actual acceleration which his pendulum would exhibit in a vacuum; and especially to determine what influence the wooden tail-pieces might have had on the original results. For, in the account of Captain Kater's experiments, it is recorded, that on the air suddenly becoming drier, the number of vibrations, which had previously been the same in both positions of the pendulum, ceased to be so; an effect which he attributed to the wooden tail-pieces losing weight by becoming drier. Major Sabine having removed the pendulum to the Royal Observatory, commenced by ascertaining its rate upon both knife-edges, in its original form unaltered, first in air of full pressure, and then in the vacuum apparatus nearly exhausted. The like experiments were repeated with the wooden tail-pieces reduced from their original length of seventeen inches to 6·4 inches, the moveable weights being altered to restore the equality of vibration. The wooden tail-pieces were next entirely removed, and brass ones seven inches long substituted for them, the weights being again altered to restore the convertibility. Lastly, the brass tail-pieces, together with the larger moveable weight, were entirely removed; and a part was filed from the heavy end, to enable the small slider to restore the convertibility.

The following are the results in the four different forms, and for both positions of the pendulum. With the wooden tail-pieces of their original length, and with the heavy end above, the daily acceleration over that in air having a pressure of thirty inches and temperature 49°, was 16·1 vibrations; and with the heavy end below, 15·7 vibrations. With wooden tail-pieces of 6·4 inches, and heavy end above, at 53°·5, the acceleration was 14·9 vibrations; below, 12·4. With brass tail-pieces, and heavy end above, at 60°, it was 12·8; below, 11·8. Lastly, without any tail-pieces, and heavy end above, at 57°·4, it was 13·7; below, 12·1. But in all of these the actual difference of pressure having been rather less than thirty inches, an allowance was made for it by simple proportion. The details are given at great length in the Philosophical Transactions for 1829 and 1831.

Major Sabine considers it a fortunate circumstance that Captain Kater had used the wooden tail-pieces just of the very sort and size as they happened to be in his original experiments, as by that means his pendulum in its original state was almost as nearly convertible in vacuo as in air. But in making this remark, Major Sabine seems to have forgotten what he had just before mentioned regarding the great effect which a change of dryness was found to have in deranging the convertibility. For if, as there is every reason to believe, the wood became much drier in vacuo from evaporating its moisture, we should be very apt to doubt the accuracy of any experiments upon, or of any comparison between, the rates of the pendulum in air and in vacuo, while so changeable a material as wood entered into its composition.

Mr B
experi
ments.

Mr Baily being also desirous of ascertaining, by a more direct process than that of M. Bessel, the true value of the correction for the numerous and various pendulums in his possession, and considering the subject to be otherwise of importance to science, resolved to devote some time to examine it more minutely, and for this purpose had a vacuum apparatus fitted up, but which is of a much simpler construction than that erected in the Royal Observatory at Greenwich, as already described. It consists of a brass cylindrical tube about five feet long and six and a half inches in diameter, rounded at the bottom, and soldered at the top to a thick iron frame, on which the agate planes rest. But the confined dimensions of this tube proved a serious inconvenience, as it could not admit Kater's and some other pendulums. The iron frame is firmly screwed and fastened to solid mahogany beams fixed to the walls in the corner of a room remarkable for its uniform temperature. The upper surface of this iron frame is ground perfectly plain, and is surmounted with a moveable bell-glass. The brass tube has two small glazed openings or windows, cut in opposite sides, for the purpose of observing the arc of vibration, and the coincidences with the pendulum of the clock, which is placed behind. The lower part of the tube is secured also by cross beams, to prevent any lateral motion. In other respects this apparatus is not materially different from that in the Royal Observatory.

The following table is a summary of the results of only a part of the experiments which Mr Baily made with this apparatus. It exhibits a comparative view of the old and new corrections for the reduction to a vacuum, together with the factor n for reducing the old to the new; as also the weight of adhesive air, or that dragged by the pendulum. The difference of pressure, we suppose, is meant to be thirty inches, and the temperature 32°. The mean of Major Sabine's, in the table on page 205, was 45°.

Kind of Pendulum.	No.	Old Correction.	Factor n.	New Correction.	Grains of Adhesive Air.
		″		″	
Sphere of platina 1·44 inch diameter, like Borda's	1	2·709	1·881	5·104	0·496
Sphere of lead 1·46 inch diameter	2	5·003	1·871	9·362	0·468
Sphere of brass 1·46 inch diameter	3	7·343	1·834	13·467	0·457
Sphere of ivory 1·46 inch diameter	4	30·080	1·872	56·310	0·472
Spheres 2·06 inches diameter.. on knife-edge Lead	5	4·988	1·738	8·668	1·115
Brass	6	7·032	1·751	12·317	1·140
Ivory	7	32·143	1·755	56·420	1·164
on cylinder..... Lead	8	4·988	1·746	doubtful	
Ivory	9	32·143	1·741	doubtful	
Brass cylinder 2·06 inches in diameter and in length, with wire, flat ends horizontal	10	6·882	1·860	12·800	1·945
with rod, flat ends vertical	11	6·859	1·920	13·169	2·378
flat ends vertical	12	6·859	1·950	13·377	2·451
flat ends horizontal	13	6·859	1·922	13·188	2·382
Brass tube 2·06 inches diameter, filled with lead, ends horizontal	14	5·448	2·032	11·070	4·558
Ditto..............ditto..............hollow, both ends open	15	22·172	1·925	42·686	4·045
Ditto..............ditto..............ditto.....top open, bottom closed	16	21·437	1·940	41·582	4·165
Ditto..............ditto..............ditto.....top closed, bottom open	17	21·955	1·975	43·378	4·283
Ditto..............ditto..............ditto.....both ends closed	18	21·227	2·000	42·468	4·454
Ditto..............ditto..............ditto.....hermetically sealed	19	25·191	2·070	52·150	4·532
Lens of lead one inch thick, 2·06 diameter, and horizontal	20	5·000	1·580	7·900	0·438
Round copper rod 58·8 inches long and 0·41 diameter	21	6·519	2·932	19·117	4·904
Kater's invariable brass pendulum	22	6·697	1·590	10·649	8·339
Kater's convertible with the wooden tail-pieces.......... with great weight below	23	7·630	2·144	16·356	
ditto................. above	24	7·630	2·204	16·815	
Plain bars two inches broad and convertible.......... $\frac{3}{8}$ inch thick....brass....... on knife-edge A	25	7·002	1·848	12·938	16·705
on knife-edge B	26	7·002	1·968	13·780	19·049
$\frac{1}{2}$ inch thick, copper.... on knife-edge A	27	6·519	1·891	12·330	20·986
on knife-edge B	28	6·519	1·991	12·980	23·276
iron........ on knife-edge A	29	7·319	1·945	14·237	22·455
on knife-edge B	30	7·319	2·064	15·107	25·435
$\frac{3}{4}$ inch thick....brass...... on knife-edge A	31	6·980	2·071	14·460	40·594
on knife-edge B	32	6·980	2·078	14·569	40·594
on knife-edge C	33	6·980	2·099	14·506	40·594
on knife-edge D	34	6·980	2·087	14·612	40·594
Long brass tube on plane A	35	18·546	2·318	42·990	45·937
on plane C	36	18·546	2·258	41·874	43·563
on plane *a*	37	18·546	2·267	42·048	44·195
on plane *c*	38	18·546	2·317	42·974	45·900
Mercurial clock pendulum, spring suspension	39	5·312	2·343	12·448	17·003
Leaden cylinder upon round wooden rod	40	5·190	2·589	13·104	17·462
Ditto.........ditto.......flat rod	41	5·190	2·827	14·312	20·120

There are several things in the table which will require some farther explanation to make them quite intelligible.

No. 1 is similar to Borda's pendulum, which is particularly described in the preceding article. Nos. 2, 3, 4 were also suspended as Borda's, and so were Nos. 5, 6, 7. Nos. 8, 9 are the same as 5, 7, but they were merely suspended by a fine wire, which was slightly held aside by the round surface of a steel wire one-fifteenth inch in diameter, a contrivance of M. Bessel, the relation of which to any practical application of the pendulum we cannot pretend to see. No. 10 is a brass cylinder with its axis vertical, and suspended by a fine wire and knife-edge. No. 11 is the same, with its axis across the plane of motion, but suspended by a knife-edge and brass rod. No. 12 is the same as the last, but with flat ends across the plane of motion. No. 13 the same, with flat ends horizontal. No. 14 is a brass tube 2·06 inches diameter and four inches long, filled with lead. It was suspended with its axis vertical by a fine wire and knife-edge. Nos. 15, 16, 17, 18, 19 are the same tube empty. No. 20 has a flat circumference about a quarter of an inch wide. It is suspended horizontally by a knife-edge and wire. No. 21 has a similar suspension. No. 22 is Kater's invariable pendulum, with which Major Sabine made the experiments described on page 205. It has a brass tail-piece about sixteen and a half inches long, for which there was not room in Mr Baily's apparatus; so that the results are those of Major Sabine, and so are the results with Nos. 23 and 24. But Major Sabine having removed the tail-pieces altogether, found the value of $n = 1{\cdot}875$ for knife-edge A, or with the heavy end below, and $= 2{\cdot}135$ for knife-edge B, or with heavy end above. Mr Baily, it is true, has slightly altered Major Sabine's numbers, by assuming a different specific gravity for the pendulum, and also for the air at a different temperature. Nos. 25, 26 are the results on the knife-edges A and B of a convertible pendulum formed of a plain brass bar 62·2 inches long. Nos. 27, 28 are those of a copper bar 62·5 inches long; and Nos. 29, 30 those of an iron bar 62·1 inches long.

The last two pendulums were taken out by the late Captain Foster, in his scientific expedition to the south, which we shall notice farther on. Nos. 31, 32, 33, 34, are the results with the four knife-edges, named A, B, C, D, of a doubly-convertible pendulum, described by Mr Baily in the Philosophical Magazine for February 1829, along with the account of some experiments which differ to an extent for which he acknowledges himself unable to give any satisfactory reason, unless it be owing to irregularities in the knife-edges and planes. It consists of a plain brass rod sixty-two inches long, without any moveable weights or sliding-pieces, and has its knife-edges convertible in pairs taken alternately; thus forming, in effect, two convertible pendulums. The distance between the knife-edges A and C was 39·3038 inches, and the number of synchronous vibrations 86218·3. The distance between B and D was 39·3084 inches, and made 86204·6 vibrations. Consequently, from these data, the lengths of the seconds pendulum will be respectively

$$\left(\frac{86218{\cdot}3}{86400}\right)^2 \times 39{\cdot}3038 = 39{\cdot}1386,$$

$$\left(\frac{86204{\cdot}6}{86400}\right)^2 \times 39{\cdot}3084 = 39{\cdot}1307.$$

The first agrees nearly with that of Captain Kater; but it is not easy to account for the discrepancy between these two results. Mr Baily does not inform us whether he had ascertained that this pendulum was perfectly free from magnetic influence, which is far from being always the case with articles of brass or copper. Nos. 35, 36, 37, 38 are the results with the four planes named A, C, *a*, *c*, which are used in place of knife-edges on a doubly-convertible pendulum formed of seven different brass tubes drawn closely one within the other, their joint thickness being 0·13 inch. The diameter of the outside is 1·5 inch, the ends are open, and the length is fifty-six inches. This pendulum is of a very singular construction; for, instead of being fitted up with steel knife-edges vibrating on agate planes, it is furnished with circular steel planes, which vibrate on a pair of fixed agate knife-edges, which are common to all the planes. The mode of suspension, therefore, is in this case reversed. The planes A and *a* are convertible, and so are C and *c*; the length between each of these pairs is very nearly a standard yard. We should, however, consider this to be rather a vague kind of pendulum, because the axis of suspension is so indeterminate that it is not restricted to such straight lines in the surface of the plane as pass through the axis of the tubes, and therefore the results must be rather indeterminate.[1] No. 39 does not materially differ from the mercurial pendulum described farther on. No. 40 is a pendulum with a spring suspension, and deal-rod three eighths of an inch in diameter, the lower part of which is encased by a leaden tube 13·5 inches long and 1·8 inch in diameter. This tube serves as the bob, and is also meant to act, by its upward expansion, as a compensation for temperature. No. 41 only differs from the preceding in having a flat deal-rod one inch broad and 0·14 inch thick, which was bevilled to a thin edge, and moved edgewise. The factor *n*, it will be seen, is greater with the flat than with the round rod. This was also found to be the case when rods of the same form as the wooden ones, but of other materials, were substituted for them.

The preceding table does not contain the half of Mr Baily's experiments. The results generally accord pretty well with the theory that a quantity of air adheres to every pendulum when in motion, and, by thus forming a portion of the moving body, diminishes its specific gravity, or rather adds to its inertia. This adhesive air seems to be confined chiefly to the two opposite portions of the pendulum which lie in the line of its motion, and very little of it adheres to or is dragged by the sides of the moving body. The shape of this coating of air will consequently partake in some measure of the form of the pendulum, subject probably to some slight modifications, of the nature of which nothing is yet known. The quantity of air dragged by the pendulum seems to depend on the extent and form of surface opposed to its action, and is not affected by the density of the body. In the case of a sphere one inch in diameter suspended by a fine wire, the weight of air dragged by the sphere alone appears to be about 0·123 grain; and for different spheres it is nearly as the cubes of their diameters. The weight of air dragged by the wire of the length of the seconds pendulum may amount to, but probably does not exceed, 0·1 grain, and perhaps is nearly the same for all fine wires of that length; so that with spheres less than an inch in diameter the weight of air dragged by the wire is nearly the same as that dragged by the sphere.

With respect to cylinders suspended by rods and swung with their flat sides opposed to the line of motion, the law of the variation is not so manifest, owing to the precise effect of the edge of the cylinder being as yet unknown. Neither are there yet sufficient data to develope the effect of the air on cylinders suspended by rods or wires, and swung with their flat sides in a horizontal position, similar to the pendulums Nos. 10 and 14. In these cases the cylinder four inches long drags much more than double the quantity of air adhering to the cylinder of two inches, although they have precisely the same diameter. With respect to very thin cylinders or discs swung with their flat sides opposed to the line of motion, the weight of air dragged by a disc of one inch in diameter appears to be about 0·149 grain, and for different discs is nearly in the ratio of the cube of the diameter; whence it appears that a thin disc drags more air than a sphere of the same diameter.

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[1] In the Philosophical Transactions for 1830, p. 207, Mr Lubbock professes to prove, that if the knife-edge is rounded or cylindrical, the distance between the planes is still the length of the equivalent simple pendulum. But in this he has deceived himself, and only proved the converse of the proposition; for it is easily shown (as we have done farther on in the precisely similar case of Laplace's theorem), that whenever the centre of gravity is within a certain distance of the middle between the planes, their distance is greater than the length of the equivalent simple pendulum. Besides, Mr Lubbock entirely overlooks the uncertainty in the position of the axis of suspension.

The last column of the table contains the weight of air which is supposed to adhere to and be dragged by the pendulum, in consequence of the air put in motion thereby, when vibrating in the mean state of the atmosphere; or rather the quantity of air which, if applied to the *centre of gyration* of the pendulum, would produce the retardation shown by the experiment. This view of the subject was suggested by Professor Airy, the present distinguished astronomer royal, who also gives the following investigation and formula for computing the weight of adhesive air. Let N denote the number of vibrations made by a pendulum in a mean solar day, when swung in air; and let ν be the additional number which it makes when swung in vacuo. Also, let ω be the weight of the pendulum in grains troy, S its vibrating specific gravity, and σ the specific gravity of the air. Now, since the force of gravity diminishes in the ratio of $(N+\nu)^2$ to N^2, or in the ratio nearly of $\left(1+\frac{2\nu}{N}\right)$ to 1, it follows, that when the pendulum vibrates in air, it is as if, retaining the inertia of its weight ω, it had the gravity of only $\omega \times \frac{N^2}{(N+\nu)^2} = \omega\left(1-\frac{2\nu}{N}\right)$ nearly; or as if it had lost the weight $\omega \times \frac{2\nu}{N}$. But the weight which it has really lost from the displacement of a quantity of air is $\omega \times \frac{\sigma}{S}$. Consequently, the portion which is not accounted for by the mere displacement of the air is $\omega\left(\frac{2\nu}{N}-\frac{\sigma}{S}\right)$, and which may be considered as the additional weight gained by the pendulum (or rather the addition to its inertia) when moving in air supposed to be *applied to the centre of gyration*. The inertia of the whole pendulum in resisting angular motion is the same as if it were collected at the *centre of gyration*. The immediate result of the experiment and formula above given is, that the inertia of the whole pendulum ought to be increased in the proportion of $\left(1+\frac{2\nu}{N}-\frac{\sigma}{S}\right)$ to 1; or that, instead of supposing the inertia ω to be applied at the centre of gyration, the inertia $\omega\left(1+\frac{2\nu}{N}-\frac{\sigma}{S}\right)$ ought to be applied there. The addition to the inertia is therefore $\omega\left(\frac{2\nu}{N}-\frac{\sigma}{S}\right)$ applied where that of the whole pendulum may be supposed to be applied, that is, at the centre of gyration.

As already mentioned, Major Sabine has alleged, that the usual formula for the reduction of the vibrations of a pendulum to indefinitely small arcs is erroneous, as it does not agree with the result of a series of experiments which he had undertaken for the purpose of testing it, and which, in the case of the convertible pendulum tried by him, would require the hitherto assumed corrections to be multiplied by 1·13 when the great weight is below, and by 1·4 when above. As this was somewhat at variance with Mr Baily's view of the matter, he determined on making a few trials, in order to ascertain more minutely, by experiment, the difference which really arises from the use of larger and smaller arcs; and for this purpose he took a brass bar convertible pendulum, placing it in the vacuum apparatus, under about one inch pressure of the atmosphere. Two series were made on the knife-edge which was nearest the end of the bar, and which he calls A, and two on the other, named B; and each of these series was divided into three portions, in the first of which the width of the arc was taken from about 1° to 0°·6, in the second from 0°·6 to 0°·38, and in the third from 0°·38 to 0°·2 and 0°·1. The first series on the knife-edge A required the usual correction to be increased about a tenth, which agrees nearly with Major Sabine's experiments; but the second series on the same knife-edge required the correction to be diminished nearly as much. Mr Baily, therefore, considers these two series as neutralizing each other, and that the difference observed must lie within the errors of observation. On the knife-edge B, both series required the correction to be increased one fifth, which is only half the amount indicated by Major Sabine's experiments. Further inquiries, therefore, are necessary to clear up this point;[1] not only as to the cause of the anomaly, whether it arises, as Major Sabine supposes, from a sliding of the knife-edges on the agate planes, in which case it may differ in different pendulums, but also as to the accuracy of the generally received formula, which several mathematicians allege to become inaccurate when the arc is very large. But whether the difference really arises from a defect in the formula, or from a sliding of the knife-edges, or from the variable effect of the air on the pendulum, or from all three, remains still to be decided. Perhaps magnetism is not always sufficiently guarded against. There are instances of articles of brass having become highly magnetic from the manner in which they have been worked; so much so, indeed, in parts of chronometers, as not only to derange their performance, but even to arrest their motions altogether. According to M. Bessel, the knife-edges slide on the planes. The sliding is proportional to the extent of the arc of vibration, and is always in the direction in which the pendulum is moving. Now, if the sliding can really be so well observed and appreciated, it must be very considerable; probably far exceeding the sliding and friction of a fine cylindric surface turning, or rather sliding round, in a nicely jewelled groove.

Defects of the knife-edges and planes.

It has been shown by Major Sabine in his work on the figure of the earth, page 195, that in a pendulum with knife-edges, a considerable difference may arise in the results, if they be used with different planes; but it does not seem to have occurred to any one versed in these experiments, till discovered by Mr Baily, that a much greater difference than that just referred to may arise while using the *same* knife-edge with the *same* plane. This fact had probably long escaped detection, from the peculiar manner in which pendulum experiments are usually conducted; for, on examining the detail of most of them, it will be found that, after the pendulum, at any one station, has been placed in its Y's, it has never been removed from them, but merely raised and lowered again as occasion may require, till it has been ultimately dismounted and packed up for another station. In this way any inconsistency that might otherwise have occurred is avoided, and consequently escapes detection. Mr Baily considers the pendulum furnished with a knife-edge and agate planes, as at present constructed, to be a very inadequate instrument for the delicate purposes for which it was originally intended; and that a more rigid examination and adjustment of those parts of the instrument are requisite, before we can depend on it, either for the determination of the length of the seconds pendulum, or even for the comparison of results obtained in different parts of the world. The knife-edge is seldom or never perfectly straight; the planes, whether from being carelessly ground, or being so thin as to be flexible, are seldom or never perfectly true; so that as there is generally a little play in the Y's, the knife-edge is not always let down on the same parts of the agate plane. This may be detected by holding a candle behind the knife-edge while it is resting on the plane; for, by means of its rays, the smallest inequalities in the points of contact are readily discernible. But the fact is rendered still more evident, by reversing the ends of the same knife-edge in the Y's, when a sensible difference in the result generally takes place. Among the numerous pendulums in Mr Baily's possession, he has only met with one whose results were not altered by an appreciable quantity when the knife-edge is reversed in the Y's, or turned half round in azimuth. If the knife-edge and plane were perfectly correct and true, there ought to be no difference in the results, whichever side of the pendulum is next the observer; whereas a difference of upwards of two vibrations in a day actually occurs in one of the pendulums above alluded to.

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[1] Mr Baily advises, that any future experiments on this question should be made in the free air, and not, as formerly, in vacuo. We should, however, have great doubts of the correctness of this opinion; for how then could the very different effects of the air on wider and narrower vibrations be distinguished from the effects which belong to the differences of the arcs themselves?

Rolling pendulum.

The theory of pendulums suspended on rolling cylinders under various forms and circumstances, is treated at considerable length, and with such ability, by Euler, in the *Acta Petropolitana* (tom. iv. part ii. for 1780), and again in the *Nova Acta* (tom. vi. for 1788), that in place of here entering into any elaborate investigation on this head, we shall now, for brevity's sake, take advantage of Euler's results, especially in examining the merits of that celebrated theorem which the late illustrious Laplace discovered about twenty years ago, and which, when it appeared, tended greatly to allay the very considerable fears which had previously existed regarding the accuracy of the experiments with convertible pendulums. For the knife-edges on which these had been suspended were considered liable to become blunted, or in some measure changed into cylindric surfaces, by their turning, under considerable pressure, on the horizontal planes; and it had been feared that this might affect the time of vibration. The theorem, though sometimes a little differently expressed, amounts to this: when a rolling pendulum is convertible, vibrating alike fast on each of two equal and parallel cylinders rolling on a horizontal plane, the distance between the cylindric surfaces is the length of the equivalent simple pendulum.

Laplace's theorem.

Though usually regarded as universally true, this theorem fails whenever the distances of the two cylinders from the centre of gravity do not differ by a quantity which greatly exceeds a diameter of the cylinders. Fortunately, it holds good in the cases which are of most importance for the convertible pendulum; but it is not perhaps much to the credit of science that the true limits of the theorem should not have been ascertained; and probably, too, from mathematicians having so much mistaken the nature of the proposition, that the reasonings hitherto employed by them in proof of it have at best amounted to demonstrations of its converse, or rather of the converse only of its possible cases, namely, that positions may always be found for two rolling suspensions of the sort above described, such, that they shall make the pendulum convertible, and have their distance equal to the given length of an equivalent simple pendulum.

The investigation of Laplace himself, while it has the defects just noticed, is so unnecessarily intricate, that it would be tedious to discuss its merits; but in the Philosophical Transactions for 1818, p. 95, the late eminent philosopher, Dr Thomas Young, has given what he considered to be a more elementary demonstration of this theorem, though it is, in fact, of its converse; and he has again, in the Philosophical Transactions for 1819, p. 94, attempted, from some of Euler's results, to deduce the same thing, but which comes to be still its converse, as will be afterwards noticed. There is likewise an abridgement of Euler's investigations for 1788 given in the Philosophical Magazine for December 1821, and with it is coupled a similar, but not more successful, attempt at deducing the theorem in question; for in all of these the proof is applicable to nothing more than the converse of the possible cases of Laplace's theorem, though that converse itself really forms a theorem which never fails.

If a be the distance of the centre of gravity of the rolling pendulum from the centre of the upper cylinder, c the radius of each cylinder, and k the radius of gyration, with respect to an axis passing through the centre of gravity of the pendulum, and parallel to the axes of the cylinders; then it has been demonstrated by Euler, in the *Nova Acta Petropolitana* for 1788 (p. 149), that this rolling pendulum will perform a small vibration in the same time as a simple pendulum whose length is $l = \frac{k^2 + (a - c)^2}{a}$. But it is easily shown that this must vibrate in a shorter time, especially with the heavier end of the convertible pendulum uppermost, than the same pendulum would do were it suspended by knife-edges substituted for, and put exactly in the places of, the cylindric surfaces. For, supposing the pendulum to continue a convertible one, after being thus modified, we should, from the well-known relation between the centres of suspension, gravity, and oscillation, have k a mean proportional between the segments into which the centre of gravity divides l the distance between the knife-edges, or we should have $k^2 = (l - a + c)(a - c)$, and thence $l = \frac{k^2 + (a - c)^2}{a - c}$, which corresponds to a simple pendulum longer than the former in the ratio of a to $a - c$. Hence it appears, that a rolling pendulum always vibrates faster than if it were suspended by a knife-edge substituted exactly in the place of the cylindric surface; so that when the rolling pendulum is a convertible one, the cylindric surfaces always have positions different from those of two knife-edges, which, with an equal interval between them, would also render the same pendulum convertible, and preserve the same time of vibration; and, therefore, to make the two proposed knife-edges keep time with the cylinders, the former would need to be shifted so as to shorten the time of vibration, which, when possible, may be effected by bringing the more distant knife-edge nearer the centre of gravity, and removing the other as much farther off, so as still to preserve an interval $= l$ between them. In that case, putting x for the space to be so shifted, we should, for the reason above given, have $k^2 = (l - a + c - x)(a - c + x)$, and $l = \frac{k^2 + (a - c + x)^2}{a - c + x}$, which, according to the theorem, is to equal the efficient length of the rolling pendulum, namely, $\frac{k^2 + (a - c)}{a}$. Wherefore, substituting the above value for k^2 in this last formula, should afford a ready means of finding such an expression for x as shall reconcile, when possible, the times of vibration on the two different sorts of suspensions; for it then becomes

$$l = \frac{l(a - c + x) - 2(a - c)x - x^2}{a},$$

whence $x^2 - \big(l - 2(a - c)\big)x = -cl$, and $x = \frac{1}{2}l - a + c \pm \sqrt{\big((\frac{1}{2}l - a + c)^2 - cl\big)}$, where both values of x, when real, will be positive, or both negative, according as $\frac{1}{2} l$ is greater or less than $a - c$. But both become imaginary; and, consequently, Laplace's theorem fails when $(\frac{1}{2} l - a + c)^2$ is less than cl; because the rolling pendulum then vibrates unavoidably faster than the other. This is, besides, still more obvious from another consideration in the case when the centre of gravity is midway between the cylinders; for then no knife-edges embracing as great an interval can give the same time of vibration, because when the knife-edges coincide with the cylindrical surfaces, they are already too slow, and would be still more so if at unequal distances from the centre of gravity. Thus, the rolling pendulum, in that case, having only $\frac{k^2 + (a - c)^2}{a} = \frac{2\,(a - c)^2}{a}$ for its effective length, must vibrate more quickly than the other, whose effective length is $\frac{k^2 + (a - c)^2}{a - c} = 2\,(a - c)$, and exceeds the former by nearly $2c$, but would be still greater were the knife-edges at unequal distances from the centre of gravity. The defects of this celebrated theorem, therefore, increase with the diameter of the cylinders; and it also appears from Euler's investigations, that the times of vibration in the rolling pendulum are more unequal, or increase still more with the width of the arc, than they do in the circular pendulum. For in the former the time of vibration is $\frac{\pi h}{\sqrt{(2ag)}} + \frac{\pi b^2 (h^2 + 4ac)}{4h \sqrt{(2ag)}}$, and in the latter $\frac{\pi h}{\sqrt{(2ag)}} + \frac{\pi b^2 h}{4\sqrt{(2ag)}}$; where b is the sine of one fourth the arc of vibration, g the force of gravity, $\pi = 3{\cdot}1416$, and $h^2 = k^2 + (a - c)^2$; but when $c = 0$, $h^2 = k^2 + a^2$ only. The second term in each of the above expressions is the respective reduction of the times of vibration, to what they should be in indefinitely small arcs.

From the equation $l = \frac{k^2 + (a - c)^2}{a}$, Dr Young, in the Philosophical Transactions for 1819, p. 94, deduces $a = \frac{1}{2} l + c \pm \sqrt{}\ldots$ The last term he leaves blank, as of no consequence, because he supposes these two values of a to be the parts into which the centre of gravity divides the distance between the centres of the cylinders, so that when added together, the two quantities affected by the radical sign, no matter of what value, should destroy one another, leaving the remaining sum $= l + 2c$, which he thence infers to be the distance between the centres of the cylinders. But this eminent mathematician, by thus omitting the quantity affected by the radical sign, has overlooked the circumstance that it, namely, $\pm \sqrt{(\frac{1}{4} l^2 + cl - k^2)}$, never vanishes, and, consequently, that his investigation does not embrace those cases in which the distances of the cylinders from the centre of gravity do not differ by far more than one of their diameters. So that the premises of the proposition which he proves do not suppose the cylinders to have given positions, or already to have positions forming a convertible pendulum, but that two positions may always be found for them, such that their time of vibration, and the interval between them, shall be equal to those of two knife-edges with given positions. In short, the proof applies to nothing more than the converse of the possible cases of Laplace's theorem.

In order to ascertain the limits of certain errors, though of a different description from those now discussed, but which may be supposed to arise in experiments with the convertible pendulum, Mr Lubbock has, in the Philosophical Transactions for 1830, investigated the effect on the number of vibrations of a given pendulum, corresponding to given deviations in the positions of the knife-edges and planes, and finds that a small deviation of one of the knife-edges in azimuth has no sensible effect. It is otherwise with a deviation in altitude; for one degree on that position of the knife-edge produces an acceleration of three seconds in twenty-four hours. Still more considerable is the effect of a deviation from horizontality in the agate planes; for ten minutes of a degree produce a daily acceleration of six seconds. Both the two latter deviations render the distance between the knife-edges greater than the length of the equivalent simple pendulum.

During the last twenty years, a vast number of experiments have been made by means of the pendulum, on the relative force of gravity in different parts of the world, with the view of contributing towards the determination of the true figure of the earth. Accounts of these have been published in the scientific periodicals, and in separate works; but our limits will only permit us to notice briefly a few which are more particularly interesting.

Difference in pendulums at London and Paris.

The length of the seconds pendulum having been determined in London by the method and apparatus of Kater, and in Paris by those of Borda and Biot, and the standard linear measures of the two countries having been respectively referred to these pendulums for future verification, an attempt was made about twenty years ago to ascertain the difference between the actual number of vibrations which invariable pendulums conveyed between London and Paris would make at these places. A summary account of the operations is given in the *Base du Système Métrique*, tom. iii.; but, from certain accidental causes, some doubts have always attached to the result. To clear up this point by solving the question anew, Major Sabine, early in the year 1827, had two invariable pendulums conveyed to Paris, where an extensive series of experiments were made by himself, and several eminent French philosophers, in the very spot where M. Biot had determined the length of the seconds pendulum. The two pendulums were next brought back to London, and similar operations were made with them in the room of Mr Browne's house, Portland Place, where Captain Kater had originally made his experiments. The comparison of the results showed, that in the latter place the pendulums made twelve vibrations more per day than at Paris, answering to 0·01088 inch in the length. The reductions, it is true, were made according to the old rules, though it is likely that this would occasion nearly equal errors in both quantities, so as not to affect their difference. The details are given at great length in the Philosophical Transactions for 1828, and the new corrections may still be applied.

Difference in pendulums at London and Greenwich.

In order the better to insure that the various pendulum experiments which had been made in Mr Browne's house, Portland Place, London, particularly those of Captain Kater, might be rendered comparable with any similar experiments made at the Royal Observatory at Greenwich, Major Sabine, at the request of the Royal Society, undertook to settle the question by direct experiment, as detailed at great length in the Philosophical Transactions for 1829. For this purpose, he first made a series of experiments on the daily rate of an invariable pendulum in Mr Browne's house, and then did the like with the same instrument taken to Greenwich. The result was, that the pendulum made 0·52 of a vibration more per day at Greenwich than at London. The knife-edge of the pendulum was then fresh ground, and a new series of experiments made at both places, with a similar result of 0·44. The mean is 0·48 of a vibration. Now, as the latitude of the Royal Observatory is 2′ 28″ south of Mr Browne's house, and as it is about fifty feet above its level, a retardation, from these causes combined, of about 0·27 of a vibration, was to have been expected at Greenwich, instead of an acceleration. The retardation, as computed for the difference in latitude, would be 0·15 vibration; and that for fifty feet of difference in elevation, being about 0·20, would, when multiplied by Dr Young's co-efficient of 0·6, be 0·12 of a vibration. These added to 0·48, make 0·75 of a vibration; by which amount the result of actual experiment differs from what might have been anticipated by mere theory.

In the autumn of the same year, 1828, Major Sabine transported the same invariable pendulum to Altona, where he made a series of observations with it. The like was done with the same instrument again in 1829, at Greenwich. The result was, that the pendulum made 8·33 more vibrations per day at Altona than at Greenwich.

Captain Foster's experiments.

The late lamented Captain Henry Foster, who had been sent out on a scientific expedition towards the south, the principal object of which was to swing the pendulum near the equator, and also at various places in the southern hemisphere, took out with him four pendulums, two of which were of the kind called Kater's invariable pendulum, but the other two were of a new construction, recommended by Mr Baily, the one of iron and the other of copper, each of which was furnished with two knife-edges; so that, in effect, Captain Foster might be considered as having taken out six different and independent pendulums. These were swung at fourteen different places, and, with the exception of the experiments with one of the brass pendulums at South Shetland, the results are very accordant, and show that the pendulum, even with its present imperfections, affords an accurate measure of the relative force of gravity at different places. But the sources of minute errors more recently detected in this instrument will render future experiments more valuable and comparable with each other. As our limits will not admit of entering into a comparative examination of the results obtained at each place, it must suffice here to state the general result at the several stations, referring, for the whole details, to the Memoirs of the Astronomical Society, vol. vii. For the purpose of deducing these results with the least chance of error, Mr Baily has adopted the usual method of minimum squares, whereby he finds that if v be the number of vibrations at the equator, f the co-efficient of the increase of the force of gravity, L the latitude of any other place where the same pendulum makes V vibrations, the general formula $V = v(1 + f \sin.^2 L)^{\frac{1}{2}}$ becomes, in the present case, and according to Captain Foster's experiments,

$$V = (7441507482 + 38666418 \sin.^2 L)^{\frac{1}{2}}.$$

The following table shows the observed mean results of all the pendulums, deduced from the whole of the experiments, at each station, as well as the value computed from the above formula, together with the error or difference thence arising.

Stations.	Latitude.	Observed Vibrations.	Computed Vibrations.	Difference.
Para............	1° 27′ 0″S.	86260·61	86264·30	—3·69
Maranham......	2 31 25	86258·74	86264·60	—5·86
Fernando de Noronha...	3 49 59	86271·20	86265·16	+ 6·04
Ascension......	7 55 23	86272·25	86268·44	+ 3·81
Porto Bello.....	9 32 30N.	86272·01	86270·32	+ 1·69
Trinidad.........	10 38 55	86267·24	86271·84	—4·60
St Helena......	15 56 7 S.	86288·29	86281·06	+ 7·23
Cape of Good Hope......	33 54 37	86331·33	86333·90	—2·57
Monte Video...	34 54 26	86334·36	86337·52	—3·16
Greenwich.....	51 28 40N.	86398·90	86401·24	—2·34
London.........	51 31 17	86400·00	86401·40	—1·40
Staten Island...	54 46 23 S.	86415·22	86413·58	+ 1·64
Cape Horn.....	55 51 20	86417·98	86417·54	+ 0·44
South Shetland	62 56 11	86444·52	86441·72	+ 2·80

The last column clearly indicates that the pendulum is powerfully affected by local circumstances, since the difference between the observed and computed results in most of the cases far exceeds the probable errors of observation, and all the pendulums agree in their indication of the degree of intensity at the several places. This fact, however, is rendered more striking by combining the experiments hitherto made with the invariable pendulum by the several English, French, and Russian voyagers. In this manner Mr Baily has obtained fifty-one different places where the pendulum has been swung; and at several of these stations this has been done by more than one experimentalist. The results, therefore, being in several instances confirmed either by the experiments of various persons, or by various pendulums swung by the same person, show most decidedly that there is some local influence on the pendulum at such stations, with the exact nature of which we are unacquainted, and which baffles all our efforts to deduce the true figure of the earth from pendulum experiments made at a *few* places only; for the results deduced from such experiments will vary according to the selection which is made of the stations. And it is a remarkable circumstance, that the force of gravity seems to be greater in islands remote from the mainland, such as St Helena, Ascension, &c. than it is on continents.

The ellipticity of the earth, deduced from Captain Foster's experiments, is $\frac{1}{289{\cdot}48}$; Major Sabine made it $\frac{1}{288{\cdot}40}$; the mean of the French and Russian experiments is $\frac{1}{267{\cdot}23}$; the mean of the whole combined, $\frac{1}{285{\cdot}26}$. The total number of coincidences made by Captain Foster was more than 20,000, and occupied upwards of 3180 hours. The total time occupied by Major Sabine was only 598 hours; that by Captain Freycinet only 367 hours; and that by Captain Duperrey only 256 hours. So that Captain Foster's experiments are five times more extensive than Major Sabine's, and fully twice and a half more extensive than those of all the above experimentalists united. They have also the advantage of having been made with a greater variety of pendulums, and cannot fail to be duly appreciated in all inquiries connected with that important subject which they were intended to elucidate, the true figure of the earth.

Among the various sources of discordance between the results of different experimenters, a fertile one seems to be the very different reductions which they use for the expansion of the air, or for reducing its density from one temperature to another. Thus, although few things in natural philosophy are better determined than the expansion of the air, almost every one uses his own favourite reduction for it. According to the experiments of Dalton, Gay-Lussac, &c., the expansion of air for one degree of Fahrenheit, and whether dry or moist, is equal to the $(t + 448)$th part of its bulk, under a constant pressure, at the temperature t. From the circumstance of this being the 480th part of the bulk at 32°, and from 32° being often used as a standard temperature, seems to have arisen the common-place phrase, that "*the expansion of air for one degree is the 480th part,*" a phrase which is always more or less erroneous, unless it mean the bulk at 32°; for it is the 448th of the bulk at the zero of Fahrenheit, the 528th of it at 80°, and the 660th of the bulk at 212°, &c. This, though an extremely simple affair, seems much too abstruse for the greater part of writers on chemistry, and for not a few on natural philosophy, among whom we find the above phrase means the 480th part of the bulk at any temperature whatever. The error is precisely of the same sort as if, because a shilling is the 480th part of twenty-four pounds, it should be reckoned the 480th part of every other sum. The greatest dunces rarely do any thing like this in the ordinary affairs of life; and why should such blunders pervade writings which profess to be scientific?

In 1830, Major Sabine having entirely removed the tail-pieces and the larger moveable weight from Captain Kater's convertible pendulum, executed a very extensive series of experiments with it at the Royal Observatory, Greenwich, for the purpose of accurately determining the length of the seconds pendulum there; and the result was, that at the temperature of 62°, and in a vacuum, it is 39·13734 inches. But notwithstanding the very great care which seems to have been bestowed on these experiments, doubts regarding their accuracy have been started by Mr Baily, particularly on account of an anomaly which occurs on the face of the observations. For it appears, that when the small sliding weight was shifted about 0·133 inch, it caused a daily acceleration of 0·10 vibration on the knife-edge A, or with the heavy end below; whilst it caused a retardation of 1·12 vibration on the knife-edge B. Now this is quite contrary to the known principles of the pendulum, since the effect of a slider of this sort is to produce an alteration of the same kind in each knife-edge, differing only in degree.

We suspect that with convertible pendulums sufficient care is not always taken to insure that the centre of gravity and both knife-edges shall be accurately in the same plane; without this the results must be very doubtful.

V.—ATTACHED PENDULUMS.

Thus far we have treated principally of what relates to detached pendulums, and of the corrections to be computed and applied to the numerical results. What follows more especially belongs to clock pendulums, and to the contrivances which enable them to correct or compensate themselves for the effects of atmospherical pressure, temperature, &c.

On examining the new correction for the mercurial pendulum, which is the one now generally employed in clocks for astronomical purposes, though, for reasons given farther on, we do not consider it as affording by any means the best compensation for temperature, it will be found that a difference of one inch in the pressure of the atmosphere should alter the daily rate of the clock by 0·414 second, which is more than double the quantity hitherto assumed as depending on the change of the barometer, and which therefore should no longer be disregarded by the astronomer. To obviate this defect in the clock at the Observatory at Armagh, Dr Robinson has attached two syphon-barometers to the mercurial pendulum, one on each side of the rod, and so placed that the variations in the height of the mercury in their tubes may exactly compensate the effect of a change of atmospheric pressure.[1] In the Quarterly Journal of Science (vol. xv.) Mr Davies Gilbert has endeavoured to show how a compensation for the effects of pressure may be produced, by making the arc of vibration just of such an extent that the effect produced by the difference of density in the atmosphere may be exactly counterbalanced by the effect arising from the difference in the arc of vibration caused by such difference of density. But by proceeding agreeably to the formula which Mr Gilbert has there given for finding the value of such arc, and on the assumption of the accuracy of the new correction above mentioned, Mr Baily finds that the required arc of semi-vibration should be 2° 45′, whereas in astronomical clocks it seldom exceeds 2°, which would produce only half the requisite compensation; so that, after following up Mr Gilbert's theory, there still remains a part of the effect, exceeding 0·2 second, on the daily rate of the mercurial pendulum, as produced by a difference of one inch of pressure. Did the extent of the arc depend on no other variable cause than the density of the air, we should think that an increase in the bulk of the pendulum would readily give the requisite addition to the compensation. For, from Mr Baily's experiments, it appears that the retardation of the air depends principally on the bulk of the pendulum, though it seems to be affected by other circumstances at present not well understood. But since the extent of the arc of vibration depends very much on the variable state of the oil, and the degree of cleanness of the clock, neither of which keeps pace with the density of the air, it seems greatly preferable to have recourse to barometers like those of Dr Robinson, and to employ a spring of suspension, having its length, if possible, so adjusted as to equalize the times of vibration in the wider and narrower arcs, which is more particularly considered farther on.

Compensation for temperature.

All bodies expand by heat and contract by cold in a greater or less degree; and consequently every attempt to discover any simple pendulum-rod, whether natural or artificial, which could continue of an invariable length, so as to have its rate of motion independent of variations of temperature, has uniformly failed. To obviate this inconvenience, a variety of devices have been resorted to by ingenious persons, and some of them with success. About the year 1715, the celebrated artist Mr George Graham attempted, by means of the very imperfect pyrometers then in use, to ascertain the relative expansions of several metals, in the expectation that the difference in some two or more of them, when applied to act in opposite directions, would enable him to construct a compound rod of an invariable length. But, owing to the defects of his pyrometer, the difference between their expansions seemed so inconsiderable, that he then relinquished all hope of effecting a compensation in this way. Some time after, it occurred to him that the great expansibility of mercury might be rendered available for this purpose; and, accordingly, in 1721 he had succeeded so far in the construction of the following kind of pendulum, that the usual error in the extremes of temperature was reduced to one eighth, as is described at length in the Philosophical Transactions for 1726.

Mercurial pendulum.

The bob or weight of the mercurial pendulum, represented in fig. 3, Plate CCCCIII., consists of a cylindrical glass jar A, containing mercury. The rod BB is of steel, and single till it reaches down thirty-two inches from the suspension, or within ten inches of the bottom, where it screws into the milled-headed nut D, in the middle of the cross bar EE of the stirrup FF, which carries the glass jar resting on the circular base G. This base, shown separately in fig. 4, is of brass, slightly hollowed to fit the jar, and a cover precisely similar to it is used on the top of the jar. Besides this, Mr Browne, with the view of keeping the surface of the mercury perfectly flat, covers it with a float of plate-glass. The jar is generally about two inches wide and eight deep, having about 6·8 inches of this depth filled with mercury; but the quantity of mercury depends very much on the weight and expansibility of the other materials. If, upon trial, the clock go too slow with an increase of temperature, showing the downward expansion of the rods to be too great for the upward expansion of the mercury, more of this fluid must be poured into the jar; if the reverse take place, some mercury must be withdrawn. In this manner may the expansion and contraction of the mercury be made exactly to compensate those of the other materials, so as to preserve invariable the distance of the centre of oscillation from the axis or other suspension. This pendulum, though in great repute, is by no means free from objection; for, since there is often a sensible difference of temperature in a small difference of height, the mercury, being much lower down than the greater part of the rod, is liable to have a somewhat different temperature, and consequently to fail in producing at all times an exact compensation. It is also alleged, that such a great mass of mercury, being enclosed in so bad a conductor as glass, does not acquire the changes of temperature so promptly as the metallic rods. To obviate this last, glass is sometimes dispensed with, and an iron cylinder, or one of brass, varnished inside to prevent the action of the mercury, is substituted for the glass. On the other hand, Captain Kater had a cylinder and rod blown all in one piece of glass, similar to a bottle with a very long neck. He had no other rod or frame. A cap of brass was clamped by screws to the top of the glass rod, and to this was pinned the suspension spring. Pendulums of this sort are said to have been at one time used in France. They are much less expensive than those with the metal rods, &c.

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[1] See Memoirs of the Astronomical Society, vol. v.

In the Philosophical Magazine for August 1819, Dr Firminger has given a description of a mercurial pendulum, with the dimensions of all the parts, apparently to a great degree of exactness, as computed by Mr Gavin Lowe for the Royal Observatory, and which have, therefore, been often copied and referred to as of standard authority. But, on examination, they will be found to be very incorrect; for, in computing the position of the centre of oscillation, and even by means of an algebraic formula, no regard is had to any dimensions of the materials but their lengths. Thus, neither the diameter of the cylinder, nor the still greater breadth of the frame or stirrup, is taken into account, although both have a considerable influence on the result.

Troughton's mercurial pendulum.

The late ingenious Mr Troughton contrived a method of constructing a compensating pendulum with much less mercury than is usually employed. Instead of the cylindrical cistern, he put the mercury into a bulb and tube in the form of a large thermometer. In that case, forty-five ounces of mercury sufficed for the compensation, but he also used an ordinary bob. According to Dr Pearson, it is a property of this contrivance, that if the column of mercury be made to reach either above or not quite up to the middle of the pendulum, at a mean temperature, the compensation will be in defect; but when the column reaches exactly to the middle, at a mean temperature, the compensation is exact. But in this there must be some mistake; for nothing can be more evident than that the column may reach exactly to the middle, while the sizes of the bulb and tube may be such as to produce nothing at all approaching to a correct compensation.

Ward's pendulum.

Ward's pendulum is a more recent one than the gridiron pendulum; but being essentially the same, and simpler in a very great degree, the description of it will form an easy introduction to that of the other. It is shown in fig. 5, Plate CCCCIII., where *aa* and *bb* are two flat rods of iron or steel, about half an inch broad and an eighth thick. Between these is a third rod *cc* of zinc, nearly the same in breadth, and a quarter of an inch thick. The one steel rod *aa* is cranked at the upper end, and the other *bb*, at the lower end, for the purpose of bringing the suspension spring and the centre of the bob to be in the same vertical line with the zinc rod. These three rods are held together by the screws *d*, *d*, *d*, *d*, but only so as still to allow them to shift with ease upon each other in a slight degree. These screws, passing through oblong holes in the rods *aa* and *cc*, screw into the rod *bb*, while the rod *aa* is held firmly to the zinc one *cc* by the single screw *e*, which, therefore, forms in effect the lower limit of the zinc rod; but since the proper length of the zinc rod can almost never be hit on at first, several holes are provided for the screw *e*, in order that on trial it may be put into the one which gives the true compensation. The steel rod *bb*, which carries the bob of the pendulum, is knee'd, so as to hook against the upper end of the zinc rod; and the other steel rod *aa* might in like manner, without the screw *e*, have hooked against the lower end of the zinc, but in that case it would not have been so easy to adjust the proper length of the zinc. The expansion of zinc exceeds that of steel in the ratio of 2·7 to one nearly. In some pendulums the zinc rod is about twenty-five inches long, in others fully twenty-seven. It is obvious, that as the two rods of steel *aa*, *bb* expand downward, lengthening the pendulum, the zinc rod *cc* expands upward, drawing up the bob by means of the steel rod *bb*, so as to raise, or rather preserve the proper position of the centre of oscillation. It is necessary that the expansion of the zinc rod should more than compensate an equal length of each of the steel rods, because they stretch beyond it both ways. But the bob itself, by expanding upward from the nut on which it rests beneath, will a little aid the compensation.

The gridiron pendulum, the invention of the celebrated John Harrison, is represented in fig. 6, Plate CCCCIII., and ordinarily consists of five rods of steel and four of brass, placed in alternate order, the former being shaded darker for distinction; but since eight of these act in pairs for the sake of steadiness, there are in effect only three rods of steel and two of brass. Their mode of action will be readily understood by tracing the expansion of the rods in the order of their connection; 1*st*, tracing down from the cross bar attached to the suspension, the two outer rods of steel, which expand downward, and act together as one rod only; 2*d*, tracing up the two brass rods next on the inside of these, which expand upward, and likewise act together; 3*d*, down the two steel rods inside of the last, which expand downward; 4*th*, up the two rods of brass next inside of these, which expand upward; and, *lastly*, down the middle rod of steel, which carries the bob, and expands downward. None of the cross pieces have any hold of the middle rod except the very short one at its upper end. The other cross pieces at some distance from the ends are double, two being on each side of the rods; but they are only fixed to the two outer rods to keep the whole system more evenly. In this arrangement, the expansion of all the steel rods is downward, and that of all the brass upward. It is necessary that the expansion of the latter metal should be much the greater, in order to compensate for there being one rod more of steel than of brass, and for the parts of steel which reach above and below the brass. But the precise compensation required is so uncertain, that the length of the rods can only be previously estimated approximately, and must afterwards be adjusted by trial if necessary. This, when well executed, is a more perfect compensation than the mercurial pendulum; because the average temperatures of the parts whose expansions are opposed to each other must be almost exactly the same. The number, order, length, and thickness of the bars often differ considerably from the above. Thus, it is evident that the whole gridiron part now described might be inverted without altering the effect. Sometimes the gridiron consists of a numerous assemblage of very short rods at the lower end of the pendulum, where they are liable to have a different temperature from that of the principal rod, which they are meant to compensate, and which has its greater part far above them. Berthoud would have liked to have deprived Harrison of the honour of inventing the gridiron pendulum, because he did not publish an account of it till 1767. But it was known to the public almost from the time it was made in 1726; and Short has described it in the Philosophical Transactions for 1751.

Graham had proposed to increase the effect of the difference between the expansions of two metals by means of levers. This was put in practice by Ellicot in a pendulum described by him in the Philosophical Transactions for 1751. Many other pendulums have been made on this principle; but, unless great care be taken to avoid friction, they are liable either not to act at all, or to move by starts in a very uncertain manner.

Some pendulums are partly composed of tubes, and these generally differ only in form from those of the gridiron construction. The following is perhaps amongst the best, as well as the simplest, of the tubular sort in use. A rod of steel attached to and descending from the suspension is covered by a tube of zinc, which rests on a shoulder or nut on the bottom of the rod; over this again is put a tube of iron or steel, having a contraction or flat ring at its upper end, to rest or hang upon the top of the zinc; and this outer tube carries at its lower end the bob or weight. This pendulum needs no farther description, being essentially the same as that of Ward, only the parts are not so equally exposed to changes of temperature. Sometimes lead is used in place of zinc, and rods of steel instead of the outer tube.

Smeaton's pendulum has a solid glass rod, covered to the extent of a foot by a tube of zinc, which rests on a nut or shoulder at the bottom of the rod, and expands upward. This is covered by a tube of iron also a foot long, hooking upon the top of the zinc, and expanding downward. The iron again has a shoulder at the bottom, on which rests a massy tube of lead incasing the other two, and expanding upward. These three tubes therefore form both the bob and the compensation. This construction is neither difficult nor expensive, but the parts whose expansions are opposed to each other are, like those of some of the pendulums already described, liable to be of somewhat different temperatures.

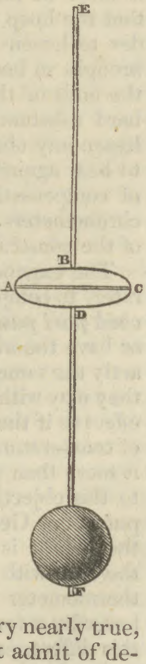
Mr Adam Reid's compensation has a very long central rod of steel descending considerably below the bob, and has this lower part covered by a zinc tube. The bottom of the zinc rests on a nut fixed on the lower end of the rod, while the bob, again, rests on the top of the zinc tube. Hence, if the zinc, by expanding upward, raise the centre of oscillation as much as the downward expansion of the long steel rod depresses it, a compensation will be effected. The length of this pendulum exposes it to much resistance from the air; and the zinc being so low down, is apt to differ materially in temperature from the steel rod. Captain Kater's pendulum of 1808, noticed below, is older than this, and only differs from it in having a wooden rod.

Somewhat allied to the last is the very home-made kind of pendulum consisting of a wooden rod partly covered by a leaden tube, and which has often received far more than its due share of commendation. Pendulums with wooden rods are described by Captain Kater, in Nicholson's Journal for 1808, and in the volume on Mechanics in Lardner's Cyclopædia; by Colonel Beaufoy, in the Annals of Philosophy for March 1820; by Mr Baily, in vol. i. Memoirs of Astronomical Society; by Mr Squire, in Philosophical Magazine for January 1825 and July 1827; and by Professor Stevelly, in the Reports of the British Association (vol. v.). This last, though professedly written in refutation of the rules given by Captain Kater and Mr Baily for the construction of compensating pendulums, is itself far from being correct; for Mr Stevelly only takes into account the expansion of the wood in so far as it affects the position of the lead, and quite overlooks it as affecting the position of its own mass; so that he provides no compensation for the wooden part of his pendulum, although he is to have such a mass of wood at the lower end of the rod that the wooden part alone is to vibrate in a second when there is no lead on it at all.

Mr Baily, probably including the suspension spring, makes the rod of deal 45·75 inches long and 0·375 in diameter; the tube of lead 14·3 inches long and from 1·25 to 2·25 inches diameter outside, with a bore just sufficient to hold the rod. Mr Stevelly uses a suspension spring two inches long; a deal-rod 44·995 inches long and 0·6 diameter; a leaden tube 16·965 inches long and 1·5 diameter outside, with a bore to fit the rod. But, without endeavouring to correct either of these rules, the safe way, we presume, is to have the tube at first too long, and then gradually to reduce it by repeated trials, because the expansion of the wood is so very uncertain. Mr Stevelly considers a bracket of wood firmly fixed on the lower end of the rod to be greatly preferable to a nut and screw for the tube to rest upon; and, to regulate the clock, he varies the length of the suspension spring in a very ingenious manner, by means of a micrometer screw, which works a nut and screw at the top of the pendulum. But of this part of the scheme we do not approve, no matter to what sort of pendulum it were applied. For we are much of the opinion which has often been advanced, that the suspension spring ought to be so contrived as to equalize the times of the wider and narrower vibrations, a great desideratum for every nice pendulum, as will be noticed more particularly afterwards. The proper length of such a spring could only be ascertained by actual trials; and if that were done, the length could not afterwards be varied without disturbing the isochronism of the vibrations. The like may be said of all those compensations whose effect depends on their varying the length of the spring, as is the case with those of Deparcieux, Julien Leroy, Fordyce, Wynn, and many others.

Although the effects of moisture in altering the dimensions and weight of the wood may be in a great measure obviated by baking, and by impregnating and coating it with certain substances, yet these again tend to increase its expansion by heat. But another objection, which applies to every pendulum in which the bob acts as the compensation, is, that the middle of the bob being far below the middle of the rod, their temperatures are apt to differ materially; and especially in this case, where the temperature of the wood must change much more slowly than that of the metal.

Bars composed of plates of two different metals, as, for instance, brass and steel soldered or riveted together, have also been used in the construction of various compensations. Thus, a bar of this sort being placed across the pendulum rod, and having the more expansible metal on the under side, carries a weight at each end. The consequence is, that a rise of temperature tends to raise the ends of the bar, together with the weights, and of course to raise the centre of oscillation; and a fall of temperature has just the opposite effect. If the bar is thin, it is apt to be in a state of perpetual tremor; and if so thick as to obviate this, it scarcely yields under the variations of temperature. Other forms of this sort of compensation are generally very complicated.



Principle of a proposed compensation pendulum.

There are many other compensating pendulums, but the most of them are either the same in principle with those we have described, or they fall under some of the objections stated in the course of this article. We shall, therefore, only add a description of the following one, wichh we presume to be new, and free from the objections just alluded to.

If an elastic hoop of metal in the figure of an ellipse have a force applied to it, as it were, slightly, to alter the length of either axis, the length of the other axis will at the same time undergo a contrary change; and the variations of these axes will be to each other in the inverse ratio of the axes themselves. Thus, if the greater axis A C were nine inches long, and a force were applied to increase it to 9·01, the smaller axis B D, if three inches, would be reduced to 2·97; or if A C were reduced to 8·99, B D would be increased to 3·03. This property we have found by trial upon a large scale to be either accurately or very nearly true, for minute variations of the axes. Whether it admit of demonstration is not of much consequence to our present purpose. Indeed, the probability of forming a hoop of an accurately elliptical figure is not very great, and as little is the chance that it would be perfectly uniform in its stiffness. Without these conditions it would be nearly useless to attempt any demonstration.

In the annexed outline of a compensation pendulum on this principle, let the elliptic hoop A B C D be of the dimensions above stated, and of steel, while the horizontal rod A C, occupying the position of the longer axis, is of zinc; since the expansions of these metals are nearly as one to 2·7, the excess of the expansion of the zinc rod of nine inches over that of an equal length of steel would still compensate $9 \times 1{\cdot}7 = 15{\cdot}3$ inches of steel. But, by the property just described, the corresponding excess of the contraction of the shorter axis B D in the vertical direction over its own expansion, being equal to three times the expansion of those 15·3 inches of steel, will compensate 45·9 inches of the steel pendulum rod EF attached in two pieces EB, DF to the opposite sides of the hoop.

This rough computation will, we presume, be sufficient to show the efficiency of such a mode of compensation, in which, if the hoop be only pressed against the rounded ends of the zinc rod by the weight of the pendulum, there need be no friction, and consequently no moving by jerks or starts, whilst the temperature is changing. It is, besides, a great recommendation to this compensation, that the hoop will readily admit of being so placed in the pendulum rod as to have the average temperature of its different parts. The construction will be easy, and attended with little expense. Perhaps, in place of a single hoop, it might in some cases be preferable to use two of a smaller and less eccentric figure, and even to employ other metals. But since the greater the eccentricity of the ellipse, the greater, within proper limits, will be the compensating effect; and therefore, by putting in a longer or shorter rod of zinc, the effect may be easily adjusted. The compensation might be still more readily regulated by forming the zinc rod in two pieces, screwing together in the middle, and thus being capable of lengthening and shortening, like the common contrivance for stretching a hat. The length of the zinc rod, when so adjusted, together with the weight of the pendulum, will readily bring and keep the hoop to the proper eccentricity, unless it has originally been very far from it, in which case it must be altered. It would, however, be an advantage that the hoop should be rather longer than the zinc, in order to lessen the pressure on the ends of the rod, when brought to bear against it by the weight of the bob. But the ends of the rod might be capped with steel or other hard substance, which could both protect the zinc and lessen any chance of friction, by presenting a sharper point to bear against the hoop. It is evident that this principle of compensation is equally applicable to the balances of chronometers. But we cannot here enter into the details of the construction.

General remarks.

The expansion of one material cannot be expected accurately to compensate that of another, unless they either proceed *pari passu* everywhere alike exposed for temperature, or have the average temperatures of their several parts exactly the same; or at least have these parts so arranged that they may with good reason be expected to produce the same effect as if the whole apparatus underwent the same change of temperature. Now, the following considerations render it more than probable that many compensations are liable to this objection, and that they are therefore unfit for the purpose. Generally speaking, the external air is colder as the height is greater, but the reverse is more commonly the case with confined air, or that within doors; so that a thermometer near the floor often indicates a temperature lower by several degrees than another near the ceiling; and this difference is said to be greater as the weather is more inclined to rain. In an upper room the ceiling is liable to great fluctuations of temperature from the vicissitudes of the weather, and, no doubt, may occasionally be much colder than the floor. But at any rate, it is found that, even in confined air, a difference of thirty-nine inches in height, which is far short of the length of many a pendulum rod, is often attended with a sensible difference of temperature. Thus, on examining the extensive tables of Mr Baily's experiments in the Philosophical Transactions for 1832, we find that he had placed two thermometers within his vacuum apparatus, the one being at the axis of suspension of the pendulum, and the other on a level with the centre of oscillation, and that they frequently differ by half a degree and more, though the apartment was one of an uncommonly steady temperature. Generally the upper thermometer was at the higher temperature, though sometimes the reverse. In some cases the air was of the full pressure, in others nearly exhausted. There is likewise reason to fear, that a difference frequently exists between the temperature of a pendulum rod and that of the parts compensating it, when the latter are separate from the pendulum and at rest, and especially when they are at some distance from it, with perhaps some board, stone, or partition intervening When a tube encloses one or more rods or tubes, it may be expected to partake sooner of any change in the air's temperature than the parts within; and still more will this be the case where several tubes successively incase one another. Besides, different materials differ greatly in the promptitude with which they acquire a change of temperature. Marble, mica, glass, and even earthenware, have sometimes been used for pendulum rods. But such substances, if slender, are extremely liable to be broken; and if thick, they are apt, from their being very bad conductors of heat, to take longer time in changing their temperatures than the other parts of the pendulum which are to form the compensation; hence, none of these materials can be compared with the metals. It is likewise to be feared that some of these will be liable to have their weights continually varying with the changes of humidity. Still more objectionable are vegetable or animal materials, owing to their changeable texture, and the perpetually varying effects of heat and moisture in altering their dimensions and weights in an uncertain manner.

Sudden alternations in the temperature of a pendulum might surely be in a great measure prevented by making the clock-case of double boards, with a small space between them, which might be either left empty, or filled with some bad conductor of heat. But we very much doubt if this, or any other simple method, could insure, that parts which are at a distance and on different levels, as, for instance, that both ends of a pendulum, would have the same temperature, the want of which is a serious objection to many a compensation, not excepting the mercurial pendulum. In all cases in which the parts of the pendulum slide or turn with friction under considerable pressure, the compensation is apt either not to act at all, or to be too long in moving, and then to go too far by a start or jerk.

Equa tion times differ arcs.

We have noticed above, and also in the article Clock-work, that the vibrations of a pendulum naturally occupy more time in the wider arcs of the same circle than in the narrower. But since the width of the vibrations is liable to be considerably affected by the state of the oil and the degree of foulness of the clock, it would be of great consequence that the rate of the clock should be rendered independent of the variable extent of the arc, because without this every compensation, whether for temperature or pressure, must at times fail to some extent, though it would only be worth the while to equalize the times in a clock having a dead beat, or detached scapement, or one whose rate is otherwise independent of any inconstant action of the wheels upon the pendulum.

Smith, in his Horological Disquisitions, published in 1694, alleged that it is possible to form the spring of suspension such that it would equalize the times of wider and narrower vibrations. The same idea was afterwards advanced by Peter Leroy, in a memoir published in 1770; and again by Berthoud, in his *Supplément au Traité des Montres à Longitude*, 1807, where he says, "la suspension à ressort bien construite tend à rendre isochrones les oscillations du pendule." In the Philosophical Magazine for April 1833, Mr Scrymgeour has given an account of his trying this with success upon the pendulums of two clocks, both of which had dead-beat scapements. The one pendulum had a wooden rod and a common lenticular bob of four pounds, with a brass ball under it of half a pound. The suspending spring was originally about three fourths of an inch long, and of a middling strength. It was then in effect shortened by fixing on each side of it a piece of steel, which was also joined to the rod. Mr Scrymgeour found, that when the length of the acting part of the spring was by this means reduced to about an eighth of an inch, the time in an arc of 3° did not differ more than half a second in twenty-four hours from that in an arc of 5°. The other pendulum was a mercurial one, with a suspending spring nearly half an inch broad and ·0083 thick. A moveable clamp was made to fasten near the top of the rod, so as to be shifted up and down at pleasure, and to clasp the spring. The times in different arcs were found to be equalized when the length of the acting part of the spring was reduced to about one twentieth of an inch. After both clocks had been kept going for a considerable time, they had lost in their rate, which Mr Scrymgeour ascribes to the gradual weakening of the spring. In this he was probably right; and if so, it seems also to show that the springs were too soft, otherwise they would rather have broken than shown any symptoms of losing their force. The usual and needless practice of softening the ends of the spring, that it may be more easily pierced for the rivets, was very likely the cause of this. However, the springs may likewise have at length acquired a little play in the slits in which they were held. For, after all, we suspect that this property of isochronism in so short a spring must have been in a great measure owing to its coming to act more closely against the corners of both slits, when the pendulum vibrated in larger arcs than in smaller. A much longer and stiffer spring, when curved into an arc of 2°, or of half a vibration, might tend to shorten the pendulum, though by an almost inappreciable quantity; but this seems nearly out of the question with a short slender spring. Neither does Hooke's law of the force of a spring being as the tension at all account for it.

We have sometimes thought, that if two pieces of a slender spring were laid together, and firmly held at both ends, the compound spring so formed would have the property of transgressing Hooke's law, so as to have its force increasing in a higher ratio than the tension. For, whilst bending at first very slightly, the one part of this compound spring would not sensibly interfere with the action of the other, and so the force of both would be only double that of either singly; but as the curvature increased, the one part would, as it were, become too long for the other, and so their joint force would be more than double that of either separately. In this way the force would increase faster than the arc of vibration, which is just the thing wanted. Such a spring would obviously break or be wrinkled useless, if it were forced through a large arc, but would safely bear to be bent through arcs more than sufficiently large for the purposes of the pendulum.

As some clocks, in place of altering the bob, are regulated by having a small weight to shift along the pendulum rod, which was a contrivance of Huygens, it may be useful here to show, that the effect of such regulating weight to accelerate the clock is greatest when it is exactly halfway between the axis of suspension and the centre of oscillation; because, unless this is kept in view, the shifting the weight upward may really make the clock go slower instead of faster, and *vice versa*. Let A be the sum of the products of all the particles of the pendulum, except those of the moveable weight, into the squares of their distances respectively from the axis of suspension, and let B be the sum of all the products of the same particles into their simple distances from that axis; also, let C be the moveable weight at the variable distance x from the axis of suspension. Since the greatest acceleration will occur when y, the effective length of the pendulum, is a minimum, and since, by the well-known property of the pendulum, $y = \frac{\mathrm{A} + \mathrm{C}\,x^2}{\mathrm{B} + \mathrm{C}\,x}$, its fluxion will then be $= 0$; or $2(\mathrm{B} + \mathrm{C}x)\,\mathrm{C}x\,dx - (\mathrm{A} + \mathrm{C}\,x^2)\,\mathrm{C}\,dx = 0$. From this we obtain $x = \pm\sqrt{\left(\frac{\mathrm{B}^2}{\mathrm{C}^2} + \frac{\mathrm{A}}{\mathrm{C}}\right)} - \frac{\mathrm{B}}{\mathrm{C}}$. Substituting now the positive value of x in the above expression for y, and reducing, it will be found that the value of y is just double that of x, or that $x = \frac{1}{2}y$. This question is treated in a very different manner, and at great length, in the *Connaissance des Tems* for 1817, by Baron de Prony, who recommends this mode of regulating, because the small weight admits of being shifted over a much more appreciable space than the bob does, and because it may be placed so high on the rod as to be readily shifted without stopping the clock. If placed above the middle of the effective length of the whole pendulum, it must be moved downward to make the clock go faster, and upward to make it go slower.

Mr Browne's mode of regulating consists in having some convenient surface so situated on the pendulum, that crooked bits of lead may either be readily put on it or removed, without disturbing the motion of the clock.

Pendulum for determining the density of the earth.

The British government has lately granted a sum of money towards defraying the expenses of repeating Cavendish's experiment for determining the mean density of the earth, and the apparatus is in the course of being constructed. But we have often thought that in this case (as well as in that proposed under the article Clock-work, vol. vi. p. 784, for determining the velocity of sound), the application of clock-work might furnish a more systematic mode of settling the question. If two accurate clocks, perfectly equal in every respect, and provided with very long pendulums, but without any compensations, were adjusted to the same rate; then, by placing one or more great masses of lead near to the ball of the one pendulum, the effect of this on its rate, if at all appreciable, would be very accurately pointed out by the difference in the times shown by the two clocks. The spaces in which the two pendulums moved could still be kept exactly equal, by placing equally near the other pendulum patterns of the lead, but formed of some light substance. In this way, with proper precaution to have both clocks at the same, though perhaps a variable, temperature, no corrections for temperature or pressure would be required, and the two clocks, left to themselves, would repeat the experiment thousands of times, and register the amount. By making the ball of the pendulum vibrate through a massy ring of lead placed vertically, with a slit at the top to make way for the rod, the clock should be accelerated. This acceleration, together with the extent of the vibrations, and the masses and dimensions of the ring and pendulum, would furnish data for computing the attraction and mass of the earth in terms of those of the ring. If the lower end of the pendulum rod were formed into a sufficiently large loop linking into the ring, it might move clear of it without the lead having any slit. But there are various other forms in which the lead might be presented to the pendulum, either to accelerate or retard it. Nay, masses might be so placed as to accelerate the one clock and retard the other.

Hardy's inverted pendulum.

Hardy's inverted pendulum, represented in fig. 7, Plate CCCCIII. is similar to an ordinary clock pendulum having a spring suspension, but only inverted. It is also furnished with a weight, which can be shifted along the rod, to render its vibrations of any required duration. This instrument has been much used by Captain Kater and others as a test for the steadiness of the supports on which their pendulums were swung; because its sensibility was believed to be such, that the slightest vibration of any thing on which it stood would set it a nodding. But the following consideration has led us to doubt its extreme sensibility, and therefore also to question whether the discrepancies in some pendulum experiments may not have been owing to the unbounded confidence reposed in this instrument. The spring which supports the rod, and connects it with the pedestal, must be incomparably more stiff in proportion to the mass of the pendulum, than is usual with springs of suspension; otherwise this pendulum would to a certainty lean over to one side, or fall down altogether. Such a stiff spring must therefore render the instrument quite insensible to any very slight vibrations of the article on which it is set. Another defect is, that the force of gravity acts upon it in the most disadvantageous manner, and makes the durations of the vibrations increase prodigiously with their width. From such considerations, we should be disposed to reject this form of instrument altogether, as not being a trustworthy test for the steadiness of supports. All we would retain of it is the mere frame, from the top of which, if a leaden ball were suspended by a thread or fine wire, it would be possessed of far greater sensibility, would have its wide and narrow vibrations nearly isochronous, and would join in or comply with the vibrations of the support, whatever might be their direction; whereas Hardy's instrument can only act in a single plane. The thread, too, could most readily have its length altered, so as to fit it for commencing its vibrations in accordance with those which might be suspected in any support.

In addition to the various references and authorities which have been mentioned in the course of this article, and in that on CLOCK-WORK, we beg to refer to the different scientific periodicals, and to the accounts of the various expeditions which have been more recently undertaken for purposes of scientific investigation. (E. E. E.)

PENELLA, a town of the kingdom of Portugal, in the province of Beira, and corregimiento of Cambra. It is situated upon an elevated spot, and is defended by two castles. It contains two churches, an hospital, and a poorhouse, 746 dwellings, and 3760 inhabitants.

PENELOPE, in fabulous history, the daughter of Icarus, married Ulysses, by whom she had Telemachus. During the absence of Ulysses, who had gone to the siege of Troy, and who staid twenty years from his dominions, several princes, charmed with Penelope's beauty, told her that Ulysses was dead, offered to marry her, and pressed her to declare in their favour. She promised compliance on condition that they would give her time to finish a piece of tapestry she was weaving; but at the same time she undid in the night what she had done in the day, and by this artifice eluded their importunity till Ulysses's return.

PENETRALE, a sacred apartment or chapel in private houses, which was set apart for the worship of the household gods amongst the ancient Romans. In temples also there were *penetralia*, or apartments of distinguished sanctity, where the images of the gods were kept, and certain solemn ceremonies performed.

PENGUIN ISLAND, a small island near the coast of New Holland, at the entrance of Adventure Bay. Long. 147. 33. E. Lat. 43. 21. N.

PENICHE, a city of Portugal, in the province of Estremadura, and corregimiento of Leiria. It stands upon a peninsula, which is divided from the continent by a narrow channel, at times nearly dry. It is fortified and protected by a citadel called Amparo, and also by a fort on Cape Carooeiro. It contains three churches, a monastery, a hospital, a poor-house, 920 dwelling-houses, and 4800 inhabitants. In the harbour, which is small, there is depth of water sufficient for large ships. The fishery affords occupation to the greater portion of the population.

PENIGK, a city of the kingdom of Saxony, in the circle of the Erzgebirge, and the capital of the patrimonial bailiwick of the same name. It is situated on the river Mulde, and contains 440 houses, with 3450 inhabitants. It has a palace belonging to the mediatized count. The chief occupation consists in making and printing cotton goods.

PENINSULA, in *Geography*, is a portion or extent of land joining to the continent by a narrow neck or isthmus, the rest being encompassed with water.

PENISA, a town of Spain, in the partida of Denia, and the province of Valencia. It contains 3200 inhabitants, who are chiefly occupied in drying raisins for distant countries, an article which is peculiarly excellent in its quality, being the growth of the vicinity.

PENISCOLA, a city of Spain, in the province of Valencia, and the capital of a department of the same name, which runs along the coast of the Mediterranean, in the north-east part. The city stands on a hill which runs out into the sea. It has a citadel, and is surrounded with walls. This place is remarkable for the purity of the air. The inhabitants amount to 3000, a great part of whom are employed in the fisheries. The fields are not so well cultivated as in most other parts of the province. Long. 0. 23. 25. W. Lat. 40. 22. 40. N.

PENITENCE is sometimes used for a state of repentance, and sometimes for the act of repenting. It is also used for a discipline or punishment attending repentance, more usually called *penance*. Besides, it gives title to several religious orders, consisting either of converted debauchees and reformed prostitutes, or of persons who devote themselves to the office of reclaiming them. Of this latter kind is the

Order of PENITENCE *of St Magdalen*, established about the year 1272 by one Bernard, a citizen of Marseilles, who devoted himself to the work of converting the courtezans of that city. Bernard was seconded by several others, who, having formed a kind of society, were at length erected into a religious order by Pope Nicholas III. under the rule of St Augustin. F. Gesnay says that they also constituted a religious order of the penitents, or women they converted, giving them the same rules and observances which they themselves followed.

PENITENTIAL, an ecclesiastical book, retained among the Catholics, in which is prescribed what relates to the imposition of penance and the reconciliation of penitents. There are various penitentials, as the Roman penitential, that of the venerable Bede, that of Pope Gregory III. and several others.

PENITENTIARY, in the ancient Christian church, a name given to certain presbyters or priests, appointed in every church to receive the private confessions of the people, in order to facilitate public discipline, by informing them what sins were to be expiated by public penance, and to appoint private penance for such occult crimes as were not proper to be publicly censured.

Penitentiary, at the court of Rome, is an office in which are examined and delivered out the secret bulls, graces, or dispensations relating to cases of conscience, confessions, and the like.

Penitentiary, a prison or place of confinement for criminals, in which the prisoners are made to labour, and a system of discipline is employed for effecting their reformation. See Prison and Prison-Discipline.

PENJINE, a river of Asiatic Russia, near the north-eastern extremity of the government of Irkoutsk. Its origin and course is but imperfectly known.

PENKRIDGE, a market-town situated within the hundred of Cuttlestone, in the county of Stafford, 129 miles from London. It stands on the river Penk, and has a market, which is held on Saturday. It is a very ancient town, being supposed to have been the *Pennocrucicum* of the Romans; but it has very little trade. The population amounted in 1801 to 1133, in 1811 to 1934, in 1821 to 2299, and in 1831 to 2351; but the parish, which is more extensive, appears by the last census to have contained 2991 persons.

PENMAN-Mawr, a mountain in Caernarvonshire, 1400 feet in height. It hangs perpendicularly over the sea, at so vast a height, that few spectators are able to look down the dreadful steep. On the side which is next the sea, there is a road cut out of the side of the rock, about six or seven feet wide, which winds up a steep ascent.

PENN, William, an eminent writer amongst the Quakers, and the planter and legislator of Pennsylvania, was the son of Sir William Penn, and born at London in the year 1644. In 1660 he was entered a gentleman of Christ-Church, in Oxford; but having previously received an impression from the preaching of one Thomas Loe, a Quaker, he withdrew, with some other students, from the national worship, and held private meetings, where they preached and prayed amongst themselves. This having given great offence to the heads of the college, Mr Penn, although only sixteen years of age, was fined for non-conformity; and, continuing his religious exercises, he was at length expelled the college. Upon his return home, he was on the same account treated with great severity by his father, who at length turned him out of doors; but his resentment afterwards abating, Penn was sent, in company with some persons of quality, to France, where he continued for a considerable time, and returned not only well skilled in the French language, but a polite and accomplished gentleman. About the year 1666, his father committed to his care a considerable estate in Ireland. Being found in one of the Quakers' meetings in Cork, he, with many others, was thrown into prison; but having written to the Earl of Orrery, he was soon after discharged. However, his father being informed that he still adhered to his opinions, sent for him to England, and finding him unmoved by all his arguments, turned him out of doors a second time. About the year 1668, he became a public preacher amongst the Quakers, and in that year was committed close prisoner to the Tower, where he wrote several treatises. Being discharged after seven months' imprisonment, he went to Ireland, where he also preached amongst the Quakers. Returning to England, he was, in 1670, committed to Newgate for preaching in Gracechurch Street meeting-house, London; but being tried at the sessions-house of the Old Bailey, he was acquitted. In September the same year his father died, and, being perfectly reconciled to his son, left him both his paternal blessing and a good estate. But his persecutions were not yet at an end; for in the year 1671 he was committed to Newgate, for preaching at a meeting in Wheeler Street, London; and during his imprisonment, which continued six months, he also wrote several treatises. After his discharge he went into Holland and Germany; and, in the beginning of the year 1672, married and settled with his family at Rickmansworth, in Hertfordshire. The same year he published several pieces, and particularly one against Reeve and Muggleton. In 1677 he again travelled into Holland and Germany, in order to propagate his opinions, and had frequent conversations with the Princess Elizabeth, daughter to the Queen of Bohemia, and sister to the Princess Sophia, mother of George I. In the year 1681, Charles II., in consideration of the services of Mr Penn's father, and several debts due to him by the crown at the time of his decease, granted Mr Penn and his heirs the province lying on the western side of the river Delaware, in North America, which thence obtained the name of *Pennsylvania.* Upon this Mr Penn published a brief account of the province, together with the king's patent; and proposing an easy purchase of lands, and good terms of settlement, for such as were inclined to remove thither, he induced many to proceed to the new settlement. These having made and improved their plantations to good advantage, the governor, in order to secure the planters from the native Indians, appointed commissioners to purchase the land which he had received from the king of the native Indians, and concluded a peace with them. The city of Philadelphia was planned and built; and he himself drew up the fundamental constitutions of Pennsylvania, in twenty-four articles. In 1681 he was elected a member of the Royal Society; and the next year he embarked for Pennsylvania, where he continued about two years, and returned to England in August 1684.

Upon the accession of James II. to the throne, he was taken into a great degree of favour with his majesty, which exposed him to the imputation of being a Papist; but from this he fully vindicated himself. However, upon the Revolution, he was examined before the council in 1688, and obliged to give security for his appearance upon the first day of next term, which was afterwards continued. He was several times examined and discharged; and at length warrants being issued out against him, he was obliged to conceal himself during two or three years. But being at last permitted to appear before the king and council, he represented his innocence so effectually that he was acquitted. In August 1699, he, with his wife and family, embarked for Pennsylvania, whence he returned in 1701, in order to vindicate his proprietary right, which had been attacked during his absence. On Queen Anne's accession to the crown, he was in great favour with her majesty, and often at court. But in 1707 he was involved in a law-suit with the executors of a person who had formerly been his steward; and, though many thought him aggrieved, the Court of Chancery did not deem it proper to afford him any relief; upon which account he was obliged to live within the rules of the Fleet for several months, till the matter in dispute was accommodated. Penn died in the year 1718.

At one period of his life Penn lodged in a house in Norfolk Street, in the Strand. In the entrance to it he had a peeping-hole, through which he could see any person who came to him. A creditor one day sent in his name, and having been made to wait more than a reasonable time, he knocked for the servant, whom he asked, "Will not thy master see me?" "Friend," answered the servant, "he has seen thee, but he does not like thee." Mr Penn's friendly and pacific manner of treating the Indians produced in them an extraordinary love for him and his people; so that they maintained a perfect amity with the English settled in Pennsylvania. He was the great bulwark of the Quakers, in defence of whom he wrote numberless pieces. The most esteemed of these are, 1. His Primitive Christianity revived; 2. His defence of a paper entitled *Gospel Truths, against the exceptions of the Bishop of Cork;* 3. His Persuasive to Moderation; 4. His Good Advice to the Church of England, Roman Catholic, and Protestant Dissenter; 5. The Sandy

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Foundation shaken; 6. No Cross, no Crown; 7. The great case of Liberty of Conscience debated; 8. The Christian Quaker and his Testimony stated and vindicated; 9. A Discourse of the general Rule of Faith and Practice, and Judge of Controversy; 10. England's Present Interest considered; 11. An Address to Protestants; 12. His Reflections and Maxims; 13. His Advice to his Children; 14. His Rise and Progress of the People called *Quakers;* 15. A Treatise on Oaths. Most of these have passed through several editions, some of them many. The letters between William Penn and Dr Tillotson, and William Penn and William Popple, together with Penn's letters to the Princess Elizabeth of the Rhine, and the Countess of Hornes, as also one to his wife on his going to Pennsylvania, are inserted in his works, which were first collected and published in two volumes folio; and the parts since selected, and abridged into one volume folio, are deservedly admired for the good sense by which they are characterized.

PENNANT, THOMAS, a celebrated naturalist, was born in Flintshire, about the year 1726. His family had their residence in that country for several hundred years; and he himself informs us that he acquired the rudiments of his education at Wrexham, whence he was sent to Fulham. Not long after this he went to the university of Oxford, where his progress in classical knowledge was very considerable, after which he turned his attention to the study of jurisprudence; but it is nowhere said that he ever followed the law as a profession.

We are informed that his taste for natural history, by his knowledge of which he afterwards became so conspicuous, was first excited by the perusal of Willughby's Ornithology, a copy of which had been sent him in a present. He began his travels at home, which was certainly the most proper step, to acquire a knowledge of the manners, curiosities, and productions of his native country, before he attempted to delineate those of any other nation. He then visited the Continent, where he acquired additional knowledge respecting his most favourite studies, and became acquainted with some of the most celebrated literary characters which that period produced. When he returned home he married, and had two children; but he was thirty-seven years of age before he gained possession of the family estate, after which he took up his residence at Downing.

On the death of his wife he again set out for the Continent, where he became acquainted with Voltaire, Buffon, Pallas, and other eminent characters. Being an author as early as the year 1750, when only twenty-four years of age, he had acquired a considerable degree of reputation in that capacity by the time he became acquainted with the above-mentioned philosophers. His reputation as a naturalist was established by his British Zoology, in four volumes 4to; and still further increased by his epistolary correspondence with no less a personage than Linnæus. He undertook a tour to Cornwall at an early period of life, and also felt an irresistible propensity to survey the works of nature in the northern parts of the kingdom. For this purpose he set out for Scotland in 1771, and published an amusing account of his tour, in three volumes 4to, which was destined to receive such a share of public favour as to pass through several editions. His Welsh tour was published in 1778, and his journey from Chester to London in 1782, in one volume 4to. About the year 1784 appeared his Arctic Zoology, a work which was very much esteemed, both in his own and in many other countries. He also gave the world a natural history of the parishes of Holywell and Downing, within the latter of which he had resided during more than fifty years. Not long before his death appeared his View of Hindustan, in two volumes 4to, to undertake which, it seems, he had solicitations from private friends, as well as the wishes of persons entirely unknown to him, which were expressed in the public prints. This was unquestionably a very bold attempt in a man who was turned off seventy, a period at which the faculties of the mind must certainly be impaired, especially when exerted with vigour for such a number of years before. Notwithstanding his great age, however, the work is executed in an able manner, bearing a strong resemblance to the introduction of his Arctic Zoology.

He also published a letter on the earthquake which was felt at Downing in Flintshire, in the year 1753; another which was inserted in the Philosophical Transactions in 1756; his Synopsis of Quadrupeds in 1771; a pamphlet on the militia; a paper on the turkey, and a volume of miscellanies.

Pennant was enabled to exhibit the greatest hospitality at his table, in consequence of the ample fortune which had been left him at his father's decease; and he gave the profits arising from the sale of several publications to charitable endowments. By his generous patronage a number of engravers met with great encouragement, and he contributed not a little to the promotion of the fine arts. About the age of fifty he married for the second time, a Miss Mostyn, sister of his neighbour, the late Sir Roger Mostyn of Flintshire. The concluding part of his life was cheerful, and it may be affirmed that he scarcely felt the advances of old age. He died at his seat at Downing in 1798, in the seventy-second year of his age.

Pennant inherited from nature a strong and vigorous constitution; his countenance was open and intelligent; his disposition was active and cheerful; and his vivacity, both in writing and conversation, made him perpetually entertaining. His heart was kind and benevolent, and in the relations of domestic life his conduct was highly worthy of imitation. The distresses in which his poor neighbours were at any time involved gave him unfeigned uneasiness, and he endeavoured to relieve them by every means in his power. He was possessed of candour, and free from common prejudices, a truth fully evinced in all his publications. The people of Scotland were proud to confess that he was the first English traveller who had fairly represented their country, in its favourable as well as in its less pleasing appearances. His style is lively, and fitted to convey the ideas which he intended to express, but it is not always correct. In zoology his arrangement is judicious, and his descriptions characteristic. If we discover several traces of vanity in those works which he published near the close of life, it ought to be remembered that it is the vanity of an old man, which is seldom disagreeable, especially when united with amiable manners and a benevolent disposition.

PENNAR, a river of Hindustan, which has its source not far from Nundydroog. It flows at first in a northerly direction until it approaches Gooty, and then takes a south-east course by Gandicotta and Cuddapah; after which it reaches the sea at Gungapatnam by an easterly course, after passing the fortress of Nelloor.

PENNATORE, a town on the sea-coast of Travancore, where the rajah of Travancore constructed a harbour for European and Chinese ships, which anchored in order to load with pepper. Long. 76. 55. E. Lat. 8. 25. N.

PENNE, a city of France, in the department of the Lot and Garonne, and the arrondissement of Villeneuve d'Agen. It stands on an elevation on the left bank of the river Lot, and contains, with its parish, 6230 inhabitants.

PENNY, in commerce, an ancient English coin, which had formerly considerable currency, but is now generally dwindled into an imaginary money or money of account. Camden derives the word from the Latin *pecunia*, money. The ancient English penny, penig, or pening, was the first silver coin struck in England; nay, the only one current amongst our Saxon ancestors, as is agreed by Camden, Spelman, Hickes, and others. The penny was equal in weight to our threepence; five of them made one shilling, or scilling Saxon, and thirty a mark or mancuse, equal to 7s. 6d. Till the time of King Edward I. the penny was struck with a cross, so deeply indented in it that it might be easily broken and parted, on occasion, into two parts, which were thence called *half-pennies;* or into four, which were called *fourthings* or *farthings.* But that prince coined it without indenture, instead of which, he first struck round halfpence and farthings. He also reduced the weight of the penny to a standard, ordering that it should weigh thirty-two grains of wheat, taken out of the middle of the ear. This penny was called the *penny sterling;* and as twenty of these pence were to weigh an ounce, the penny thus became a weight as well as a coin. The penny sterling was long disused as a coin, and was scarcely known, except as a money of account, containing the twelfth part of a shilling; but latterly it has been introduced into the British current coin.

PENNYWEIGHT, a Troy weight, containing twenty-four grains, each grain weighing a grain of wheat, gathered out of the middle of the ear, and well dried. The name took its rise from the circumstance that this was anciently the weight of one of our silver pennies.

PENORCON, an old musical instrument of the guitar kind, with nine strings and a broad finger-board.

PENRITH, a market-town and parish in the ward of Leath, in the county of Cumberland, 284 miles from London, and seventeen from Carlisle. It is an ancient town, which in the wars between England and Scotland frequently changed masters; and near to the town, on the bank of the river Emont, are now shown two curious caverns, said to have been occupied by the peaceable inhabitants during the frontier excursions of the two nations. The parish church is a handsome structure, of old date, but modernized. There are markets, which are held on Tuesday and Saturday; and there are some manufactories for woollen and cotton goods. The population amounted in 1801 to 3801, in 1811 to 4328, in 1821 to 5385, and in 1831 to 6059; but in it is included that of the whole parish, comprehending the townships of Burrogate, Dockray, Middlegate, Sandgate, Carelton, Nether-end-bridge, and Plymton.

PENRYN, a borough-town of Cornwall, in the hundred of Kerrier and parish of St Gulvian, 266 miles from London and three from Falmouth, with the harbour of which it has a water communication. It has a corporation, with twelve aldermen, twelve common-council men, and a recorder; and it continues to return two members to the House of Commons. It has considerable trade in the pilchard and Newfoundland fisheries, and in Cornish granite, which is found in abundance around it. There are markets, which are held on Wednesdays, Fridays, and Saturdays. The population amounted in 1801 to 2324, in 1811 to 2713, in 1821 to 2933, and in 1831 to 3521.

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PENNSYLVANIA, one of the United States of North America, and, in point of manufactures, the most important in the Union. As now limited, it extends from 39. 43. to 42. 16. of north latitude, and from 74. 35. to 80. 31. of longitude west from Greenwich. It is bounded on the north by New York; on the east and north-east by the river Delaware, which separates it from New Jersey; on the south-east by the state of Delaware; on the south by Maryland and part of Virginia; and on the west by the latter state and part of that of Ohio. Darby, in his Geographical View, makes its greatest length to be 315 American statute miles, and its greatest breadth 176 miles, thus comprehending an area of about 47,000 square miles, or 30,080,000 statute acres. The most prominent natural features which strike the eye at the first glance of a map of Pennsylvania are the mountains. Scarcely any part of it is entitled to be called level; and it may be doubted whether a more widely-diversified region exists upon the face of the earth, or one of similar area in which the vegetable and mineral productions are more numerous. The Appalachian range in the United States generally extends in a direction deviating not very essentially from the south-west to the north-east; but in Pennsylvania the whole chain is deflected from that course, and traverses the state in a serpentine direction. Towards the southern boundary, the mountains run nearly north-north-east, but gradually incline more eastwardly as they penetrate northward; and in the central counties many of the chains run nearly east and west. But as they approach the northern limits of the state they again gradually incline to the north-east, and enter New York and New Jersey nearly in that direction. The principal ridges are the Blue Mountains, behind which, and nearly parallel with them, are other smaller ridges. On the west side of the Susquehannah are the Kittatinny ridges, which are succeeded by the great Alleghany ridge, the largest of all, and which gives name to the whole system. West of these mountains, Pennsylvania consists of hill, dale, and plains, having a surface not unlike to that of New England. In respect to surface, this state is divisible into three natural sections, viz. first, a small but important hilly tract between the marine alluvium and the lower ridges of the Appalachian system, which is called the eastern section, and comprises 7869 square miles; secondly, the mountainous or middle section, comprising 25,189 square miles; and, thirdly, the western or hilly section, comprising 13,942 square miles. The highest peaks of the Alleghanies are elevated from 2000 to 3000 feet above the level of the sea. This middle region, chiefly occupied by Germans, presents all varieties of scenery, the grand, rugged, and romantic, blending with the sheltered, the beautiful, and the cultivated. Some of the mountains admit of cultivation almost to their summits, and the valleys between them are in general rich and fertile.

The principal rivers are the Delaware, the Susquehannah, Schuylkill, Lehigh, Alleghany, Monongahela, Ohio, Juniatta, Youghiogeny, and Clarion, formerly called Toby's Creek. The Susquehannah is the largest Atlantic river of the United States. It rises in the state of New York, near the sources of the Mohawk, and, flowing in a south-westerly direction, enters Pennsylvania, but afterwards bends its course back into New York. Still seeking an outlet to the west, it returns into Pennsylvania, and receives the Tioga River, the West Branch, and the Juniatta. These accumulated waters swell it to a broad stream, which, passing Harrisburgh, enters Maryland, and finds its estuary in Chesapeake Bay, at Havre-de-Grace, after a course, measuring its curves, of more than five hundred miles. It has a number of tributaries, the largest of which is the Juniatta. This stream has its origin in the Alleghanies, from two large branches which rise a little above Huntingdon. The united river divides again, and by two mouths enters the Susquehannah fourteen miles above Harrisburgh. Lehigh is an important branch of the Delaware. It finds its way through several hills, and, amongst others, through the Blue Ridge. After passing the Moravian towns and a beautiful country, it falls into the Delaware at Easton. The canals have enabled the great cities to avail themselves of the rich and exhaustless coal-beds near its banks. Schuylkill rises amongst the mountains of Schuylkill county, and, winding through a rich country, and the towns of Reading and Pottstown, supplying Philadelphia with water in its course, it falls into the Delaware about seven miles below the commercial metropolis of Pennsylvania. It has a long course; and the locks and canals have rendered it navigable, so that the immense beds of anthracite coal at its head sources are rendered available to Philadelphia and the country on the coast.

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Besides these main streams, Pennsylvania is watered by numerous large creeks and rivulets to as great a degree as any equal extent of country in the United States. Many of these, besides irrigating and fertilizing the rich interior of the state, likewise furnish admirable water power.

The soil of Pennsylvania is much diversified. In some parts it is barren, but a great proportion of it is fertile, and not a little very excellent. West of the mountains the soil of the first quality is a deep black mould, equal in fertility to that of any part of the United States. Pennsylvania is emphatically a grain country, wheat being the most important article of produce. Indian corn, rye, buck-wheat, barley, oats, flax, hemp, beans, peas, and potatoes, are also extensively cultivated; thus, with the exception of rice, embracing all the cerealia raised in the United States. From the difference of level in the state, it admits a great diversity of other vegetable productions. Amongst fruits, apples, cherries, pears, peaches, and plums are abundant. Of indigenous forest-trees there is equal variety, including hemlock, pine, hickory, walnut, wild cherry, locust, maple, chestnut, mulberry, oak, gum, sassafras, elm, and poplar. Grapes are common, and the wild plum and crab-apple abound. In some counties foreign grapes have been advantageously cultivated, and wine and brandy of good quality have been made from them, but not to any extent. The sugar maple in the western and northern parts of the state is abundant, and sugar is made from it in sufficient quantity to supply the home consumption. Many parts of the state produce fine meadow-grass, and in these the products of the dairy are abundant. Pennsylvania is famous for its breed of draught horses; and nature has abundantly supplied the forests with game. Deer, turkeys, pheasants, and partridges, are numerous; and wild ducks are found in almost every stream. Wild geese, swans, and pigeons are migratory, and frequently found in large flocks. Bears, panthers, wild cats, wolves, and other original tenants of the forests, are more and more disappearing as settlement and cultivation extend. In the low grounds are found minks, musk-rats, and opossums; and snakes form a numerous tribe; but the bite of the rattlesnake and copperhead alone is deadly. In the eastern rivers are found rock-perch, bass, shad, and herring, which latter come from the sea in large shoals. In the western waters there is a species of cat-fish, weighing from fifty to a hundred pounds; and pike likewise of an enormous weight and size are found. Sturgeon are common to both these sections of the state. In the smaller streams trout, chub, sun-perch, mullet, white salmon, and other species of fish, are found in their several seasons.

Pennsylvania is very rich in minerals and metals. Iron ore is distributed throughout many parts of it, and the manufactures of iron are carried on to a greater extent than in any other state in the Union. Copper, lead, and alum appear in some parts; and limestone and marble, of the finest quality for the purposes of architecture and statuary, are abundant. In the middle counties anthracite, and in the western bituminous coal, are found in inexhaustible quantities. The bituminous coal-lands in Pennsylvania are estimated by a committee of the legislature of the state to comprehend an extent of 21,000 square miles, and the anthracite of 975 square miles. Since the opening of the anthracite coal trade in 1820, its average annual increase has been thirty-three per cent.; and the committee believe that it will continue to increase in the same ratio for some years to come.

During later years Pennsylvania has engaged very extensively in works of internal improvement, more so than any other state in the Union. The Pennsylvania Canal and Railroad, extending from Philadelphia to Pittsburgh, forming a connected line of communication nearly 400 miles in length, claims particular attention as a most magnificent work. Railroads have been laid out on a very extensive scale, and numerous turnpike roads and bridges have been constructed in a superior style of excellence and durability. The first turnpike road in the United States was made in Pennsylvania. At the end of 1836 the state canals in operation extended 600 miles, and the state railways 120 miles. The canals constructed by incorporated companies extended 286 miles, and the railways 106 miles. Besides these, a great number of others were in course of construction, and many of them were far advanced towards completion.

The manufactures of Pennsylvania comprehend those of cotton, woollen, iron, leather, paper, glass, ropes, and various others which supply the demand for the luxuries as well as the necessaries of life. Flour and meal also constitute important articles in the trade of this state. In the year 1831 there were in the state 67 cotton-mills, having 120,810 spindles; and there were manufactured 21,332,467 yards of cloth, with 7,111,174 lbs. of cotton used. In connection with the iron manufactures there are a vast number of blast-furnaces, air-furnaces, forges, trip-hammers, rolling and slitting mills, and naileries. In the year 1831 there were one hundred steam-engines in Pittsburgh alone. In its iron manufactures Pennsylvania far excels every other state in the Union; and, after cotton, the next in importance are those of paper and leather. The coal trade of Pennsylvania promises to be of great importance to the state, and even to the whole Union. There are three anthracite coal-mines, those of Schuylkill, Lackawana, and Lehigh. The quantity of coal taken from the first-named mine in 1834 was 224,242 tons, from the second 106,500, and from the last-named 42,700. The Lehigh mines were first wrought in 1820, the Schuylkill in 1825, and the Lackawana so late as 1829. The whole quantity shipped from the three mines, from the time when they were first opened for the market, up to the 1st of January 1836, was 2,498,024 tons. The value of the exports and imports of Pennsylvania for the year ending 30th of September 1836 was as under: Value of imports in American vessels, 14,172,453; in foreign vessels, 895,780; total, 15,068,233 dollars. Value of exports of domestic produce, 2,627,651; of foreign produce, 1,343,904; total, 3,971,555 dollars. The number of vessels which entered Philadelphia during the preceding year was, American 348, their tonnage being 68,177; and foreign sixty-eight, their tonnage being 10,816; total, 416 vessels, of 78,993 tons burden. Ship-building is carried on to a considerable extent in Pennsylvania. For the year ending 1836 there were seventy-four vessels built, their tonnage being 10,214.

The financial concerns of the state stand thus:

Receipts for the year 1836............	4,000,437·64	dollars.
Payments ditto..........................	3,675,638·11	...
Balance in the treasury..................	324,799·53	...

The public debt, relating chiefly to public improvements, was 24,970,762; and the public property, consisting principally of public works and of bank stock, was 29,106,801 dollars. From this statement it appears that the value of the property belonging to the state exceeds the amount of debt by 4,136,039 dollars. On the 1st of December 1836, the number of banks in Pennsylvania was fifty; and the capital authorized, 59,658,482 dollars; a return which, however, was not believed to be complete, though it may be considered as nearly correct. In November 1835 there were only forty-four banks, the condition of which is thus stated: Specie 3,876,868, circulation 10,932,023, deposits 13,347,977, capital 18,858,482 dollars. The amount received for postage in 1834 was 343,406 dollars, which is about 87,000 lower than that of New York, but double the sum for postage received in any other state.

The ecclesiastical statistics of Pennsylvania for the year

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1834 were as follows: Presbyterians, 475 churches; Methodist Episcopal church, 252 ministers; Evangelical Lutheran church, 312 places of public worship; German Reformed church, 150 ditto; Baptists, 157 ditto; Friends, 150 ditto; Roman Catholics, fifty-six ditto; Church of the United Brethren, eleven ditto; Associate Presbyterian church, twelve ditto; Reformed Dutch church, eight ditto; New Jerusalem church, seven ditto; Unitarians, five ditto; and the Universalists, one convention. The Lutherans, the German Reformed, the Friends, and the United Brethren, are more numerous in this state than in any other. With the exception of the Friends, whose spiritual teachers are not allowed any salary if they are at all able to support themselves without it, the ministers of religion, in general, are supported by voluntary subscriptions, contributions, and rents of pews. The facilities of receiving education in Pennsylvania are very great. The state has made grants of money and land at different times to colleges and academies, the gross amount of which is estimated at 485,000 dollars. In the year 1837, there were no less than ten colleges in Pennsylvania, besides law, medical, theological, and other schools. The university of Pennsylvania, founded in Philadelphia in the year 1755, is a highly respectable institution, embracing the departments of arts, medicine, natural science, and law. In the medical department there are seven professors, attended by above four hundred students. According to an official document published in 1837, eight of the academies which have received aid from the state report their having eight hundred and forty-one students, and a hundred and sixteen graduates, in 1836. The funds were estimated at 333,000 dollars, of which sum the property of the university of Pennsylvania alone amounts to 186,000. In three of the libraries there were 11,200 volumes. The university of Pennsylvania itself, however, possesses 44,000 volumes. There are a great number of academies and common schools, both these kinds of institutions having received considerable aid from the state funds. By the new school-laws of the state, which were passed in 1835, each county is left to determine by its votes whether it will entitle itself to the aid of the public fund, by assuming a certain proportion of the expense. The whole number of districts, according to the report already mentioned, is 987, and the number of common schools 3349. The city and county of Philadelphia constitute a school district, and are not included in the above statements. By the last annual report it appears that above 11,000 children are taught at the expense of the country. The whole number of children in the state between the ages of five and fifteen is about 320,000; but the number of scholars in the common schools is only 150,838, so that education in Pennsylvania is still somewhat limited. But when the new laws relative to this important object shall have taken full effect, a decided improvement will no doubt take place. The principal literary seminaries in this state, besides the university at Philadelphia, are, Dickinson College at Carlisle; Jefferson College at Canonsburgh; Washington College at Washington; Western University at Pittsburgh; Alleghany College at Meadville; Madison College at Union Town; Mount Airy College at German Town; the Theological seminaries at Gettysburgh, York, and Alleghany Town; and the Moravian schools at Bethlehem, Nazareth, and Litiz. By the will of a wealthy citizen of Philadelphia, who died in 1831, a fund of two millions of dollars (to be augmented, if necessary, by rents of real property, and residuary personal estate) has been appropriated for the establishment of a college for the education of orphan children. There are other benevolent institutions in the cities and towns of Pennsylvania, such as the necessities of a populous manufacturing country require; but being similar to those of New York and other large cities, they need not be particularly specified. Philadelphia is celebrated for the extent of its establishments in connection with the diffusion of knowledge. Paper-making, printing, and publishing, are carried on with great enterprise; and a vast number of gazettes, periodicals, monthlies, and quarterlies, are issued. "This city, besides, vies with Boston," says Mr Flint, "in the number and extent of its school and classical books. If Boston publishes, as regards material and execution, more substantially, Philadelphia publishes cheaper, a circumstance often as important in the extension of its books." Boston had the honour of publishing the first newspaper in the British colonies in America, which appeared in 1704. Philadelphia followed in 1719; and since that time they have multiplied in Pennsylvania more rapidly than in any other state, with the exception of New York. In the year 1834, there were published two hundred and twenty newspapers, of which thirteen were daily papers; and the number of periodical journals, of various kinds, amounted to thirty-two.

The population of the counties and county towns of Pennsylvania in 1830 was as follows:

Counties.	Population.	County Towns.	Population.
Adams	21,379	Gettysburgh	1,473
Berks	53,357	Reading	5,859
Bucks	45,740	Doyleston	1,262
Chester	50,908	West Chester	1,258
Cumberland	29,218	Carlisle	2,523
Delaware	17,361	Chester	848
Dauphin	25,303	Harrisburgh	4,311
Franklin	35,103	Chambersburgh	2,794
Lehigh	22,266	Allentown.	
Lancaster	76,558	Lancaster.	
Lebanon	20,546	Lebanon	7,704
Montgomery	39,404	Norristown	1,826
Northampton	39,267	Easton	1,089
Perry	14,257	New Bloomfield	3,529
Philadelphia[1]	108,503	Philadelphia	167,811
Pike	4,843	Milford.	
Schuylkill	20,783	Orwigsburgh	773
Wayne	7,663	Bethany	327
York	42,658	York	4,216
Western District.			
Alleghany	37,964	Pittsburgh	12,542
Armstrong	17,625	Kittaning	1,620
Beaver	24,206	Beaver	914
Bedford	24,536	Bedford	870
Bradford	19,669	Towanda.	
Butler	14,683	Butler	580
Cambria	7,079	Ebensburgh	270
Centre	18,765	Bellefonte	699
Clearfield	4,803	Clearfield.	
Columbia	20,049	Danville.	
Crawford	16,005	Meadville	1,070
Erie	16,906	Erie	1,329
Fayette	29,237	Uniontown	1,341
Greene	18,028	Waynesburgh.	
Huntingdon	27,159	Huntingdon.	
Indiana	14,251	Indiana	433
Jefferson	2,225	Brookville.	
Luzerne	27,304	Wilkesbarre	2,233
Lycoming	17,637	Williamsport.	
M'Kean	1,439	Smithport.	
Mercer	19,731	Mercer	656

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[1] Without the city of Philadelphia.

Counties.	Population.	County Towns.	Population.
Mifflin	21,529	Lewistown	1,479
Northumberland	18,168	Sunbury	1,057
Potter	1,265	Cowdersport.	
Somerset	17,441	Somerset	649
Susquehannah	16,777	Montrose	415
Tioga	9,062	Wellsborough.	
Union	20,749	New Berlin.	
Venango	4,706	Warren.	
Warren	42,860	Washington	1,816
Washington	9,128	Franklin	409
Westmoreland	38,400	Greensburgh	810

The total population of Pennsylvania amounted in 1830 to 1,347,672, of whom 403 were slaves. The inhabitants are principally descended from the English, Welsh, Irish, Scotch, and Germans; besides Swedes, French, and a few Dutch. The language, in general, is English, but in many of the counties the German prevails to a considerable extent. The character of the Pennsylvanians is somewhat diversified by difference of extraction and variety of the modes of education, but this is chiefly in minor points. The law regarding aliens provides that their friends may purchase lands, tenements, and hereditaments within this commonwealth, not exceeding five thousand acres, and may have and hold the same as fully as any natural-born citizen. Such persons may also acquire, take, hold, and dispose of real estate by descent or devise, in as full and ample a manner as the citizens of the state.

The commercial capital of Pennsylvania is Philadelphia; but the political metropolis is Harrisburgh, pleasantly situated on the eastern bank of the river Susquehannah, nearly one hundred miles west from Philadelphia. At this place there is erected a covered bridge of twelve arches over the river, the construction of which cost nearly two hundred thousand dollars. The Pennsylvania Canal passes along the eastern side of the town, and forms a large basin for a harbour. Harrisburgh is regularly laid out and well built, consisting chiefly of brick. The capitol is a spacious and elegant edifice, situated on a considerable elevation on the outside of the town. The other public buildings are, a county court-house, a jail, two or three banks, a large Lancasterian school-house, about twelve places of public worship, and a number of printing offices, from six of which newspapers are issued, two of them in the German language. It has also a steam-mill, with a variety of manufacturing establishments, and is a place of considerable trade. Fifty or sixty years ago Harrisburgh was a wilderness inhabited by savages. It is now the capital of the second state in importance in the North American Union, with a population which in 1838 may be estimated at between six and seven thousand souls.

Lancaster, the capital of the richest and most fertile county in the state, is delightfully situated near Conestoga Creek, which falls into the Susquehannah sixty-two miles west from Philadelphia. It is a very healthy and flourishing city, and carries on an extensive trade with the surrounding country. The houses are well built; and amongst the numerous public edifices may be mentioned Franklin College, which was founded in 1787. There are churches, banks, schools, literary and charitable societies, sufficient for the wants of the inhabitants; and eight or nine newspapers are published in the English, and four or five in the German language. The inhabitants are mostly of German descent, and many speak the language of the land from which they sprung; but the English predominates. There are in Lancaster seventeen distilleries, and several tan-yards, breweries, and potteries. This town was laid out in the year 1730, and became early celebrated for the excellency of its stockings, saddles, and guns; it is still famous for its rifles, and the number and excellence of the stage-coaches built there. The population in 1838 was estimated at about 9000. Lat. 3. 40. N. and long. 76. 10. west from Greenwich.

Reading, also in the centre of a fine agricultural country, is situated on the east bank of the Schuylkill, and contains a number of public buildings. Being connected with Philadelphia by the line of the Pennsylvania Canal, its trade is rapidly advancing, and manufactures are also increasing. Many fine mills have been established in the vicinity, there being an ample command of water-power. The population of Reading in 1838 was reckoned at about 7500. Carlisle is an interior post-town, sixteen miles west from Harrisburgh, and 116 west from Philadelphia. It is pleasantly situated, and regularly laid out, being built chiefly of stone and brick, and it enjoys considerable trade. Dickinson College, founded here in 1783, is a flourishing institution. This town has rapidly increased, and the population in 1838 was about six thousand. Chambersburgh is situated ninety miles west from Philadelphia. The stream on which it stands furnishes water-power for many manufactories, of which the town already contains a considerable number. Blue-stone, free-stone, and marble, abound in the vicinity; and it has turnpike communications with Philadelphia, Baltimore, and Pittsburgh. The population in 1838 was estimated at above 4000. York is situated on Codoru's Creek, eighty-five miles west from Philadelphia. It is in the centre of a fertile and beautiful country, and is a handsome town, containing a number of public buildings, and a population in 1838 of above 6000. Bethlehem, Easton, Lebanon, and New Bloomfield, are all towns more or less in a flourishing state, and containing from 4000 to 8000 inhabitants.

Pittsburgh, the capital of the western district of Pennsylvania, is situated in a beautiful plain on a point of land where the Alleghany and Monongahela unite to form the river Ohio. The site of the town was early regarded as very important, and was selected by the French for Port du Quesne, one of the principal fortified places in the great chain of posts which was to connect Canada with Louisiana. It was the scene of more than one battle, and before this place Washington gained his first laurels. The name was afterwards changed to Fort Pitt, and finally to Pittsburgh. A considerable town soon rose around the fort; but the Indian wars, and the troubles of the western country, prevented its rapid growth until 1793, although the present Pittsburgh was commenced in 1765. It is now, in the extent of its manufactures, the only rival of Cincinnati in the west; and in population, wealth, and importance, it is next to that city, and the third in the valley of the Mississippi. In general the town is well built, some of the streets being handsome, and the public buildings spacious; but the whole has a gloomy or dingy aspect, from the dust and smoke of the pit-coal used in the manufactories and houses. The coal is found in the neighbourhood in inexhaustible quantities, and is easily obtained. Pittsburgh is well provided with houses of public worship for various sects, and has a public library, several banks, and a theatre. The manufacturing establishments are probably more numerous and extensive than in any other town in America in proportion to its population. In its manufactures it resembles Birmingham in England, those carried on upon a great scale being ironmongery of every description, steam-engines, and iron work in general; cutlery of all descriptions; glass and paper, cotton and woollens, pottery, chemical preparations, tin and copper ware, all which are produced to the value of 3,000,000 of dollars annually. Boat and steam-boat building have been pursued here on a greater scale than in any other town in the western country. The market is abundantly supplied, but the cost of articles is much higher than in the towns farther west on the Ohio. At low stages of the water flat and keel-boats cannot always descend the river from

Pittsburgh, which circumstance diverts to Wheeling a part of the travel to the western country; still a great part of it centres at Pittsburgh, and, in high stages of the water, steam-boats are continually arriving and departing. Pittsburgh has immense advantages in point of artificial as well as natural water communications. The great Pennsylvania Canal terminates here, and others connect it with various parts of the country. The inhabitants are a mixed race of Germans, Irish, English, Scotch, French, Swiss, and many other nations, and are distinguished for industry and economy. The Western University, founded here in the year 1820, is a thriving institution; and there are, besides, a number of seminaries of education, and benevolent societies. The suburbs of Pittsburgh are Alleghany Town, Northern Liberties, Birmingham, and Lawrenceville. Pittsburgh is the seat of justice for the county of Alleghany, and is situated in latitude 40. 32. north, and longitude 88. 0. west from Greenwich. The population of Pittsburgh, including the suburbs, may be estimated at nearly 30,000. The following observations by Mr Flint will serve to convey an idea of the importance of this state, and the rapid advances which it has made, and is still making.

"A single fact from the census of 1830 will illustrate the vigorous advance of this great state in population and importance. The aggregate increase of twenty-eight towns is sixty per cent. In 1829, 297,206 barrels of wheat flour, 39,523 of rye flour, and 1609 hogsheads and 6433 barrels of corn meal, were inspected in Philadelphia." In fact, "it spreads a wide surface in the Ohio valley, rapidly advancing in wealth and population. New towns are springing up in every direction. It abounds in all the elements of wealth and power. Public opinion has given it a strong impulse towards manufactures, and a gigantic system of internal improvements. Its inhabitants, though composed of all nations, are distinguished for their orderly habits, industry, and sober progress of thrift, and a sturdy spirit of political independence. The passing stranger, as he traverses the state, is struck with the noble roads and public works, with the beautiful German farms, and their magnificent and imperishable stone houses, and often still more magnificent stone barns. An agricultural country, alike charming and rich, spreads under his eye. He not only passes many handsome towns, but is surprised with the frequent recurrence of neat and populous villages, the names of which he had met in no itinerary or gazetteer. He sees a country of immense agricultural resources."

Pennsylvania was originally settled by a Swedish colony, which went over in the year 1638, under the government and protection of Sweden. The Dutch and Finns had likewise settled on the river Delaware, previously to the British conquest of the New Netherlands in the year 1664. In 1682, the celebrated William Penn founded a colony here, having obtained a charter from Charles II. which put him in possession of the soil and the government of the country. In the following year emigration to Pennsylvania from Wales commenced, the colonists purchasing a large extent of land, and calling the several settlements after favourite places in their native country. The Indian right was respected by William Penn, whose sense of justice induced him to make an equitable purchase from the aborigines, notwithstanding his charter; and the same policy was pursued by the constituted government after the American revolution, when the state of Pennsylvania made new purchases from the native proprietors at a fair price, and in open treaty, in the year 1784. Although the state of Pennsylvania might have considered the proprietary claims as a royalty to which the independent government could lawfully succeed, yet, as a peculiar acknowledgment of the merits and claims of William Penn and his family, the legislature offered to confirm the heirs of Penn in the title to the manor lands, which were ten per cent. of all the surveyed lands in the province, and to grant them a sum of L.130,000, which offer was accepted. This was a liberal compensation for revolutionary losses, considering that, in the year 1712, William Penn had offered to the queen of England the government and soil of the province for the sum of L.12,000; and the transference would have taken place had not an apoplectic attack rendered him incapable of completing the legal claim. A litigated question with the neighbouring state of Connecticut, touching the right of territory in the northern part of Pennsylvania, was in dependence, from the year 1750, for more than seventy years, when the public and private rights to the soil were settled in favour of this state, under conciliations and restrictions, determined by special acts of the Pennsylvania legislature, and the decisions of the supreme court of the United States. The seat of the state government was transferred from Philadelphia to Lancaster in the year 1799; and the progress of improvement and population caused it in 1812 to be removed to Harrisburgh, where handsome buildings are erected for the accommodation of the legislature and the officers of the government.

From the beginning of the eighteenth century until the commencement of the American revolution, the government was generally administered by deputies appointed by the proprietors, who were mostly resident in England. The first constitution of Pennsylvania was adopted in 1776, and the present constitution in 1790. The legislative power is vested in a general assembly, consisting of a senate and house of representatives. The representatives are elected annually on the second Tuesday in October, being apportioned according to the number of taxable inhabitants. The number cannot be less than sixty, nor more than a hundred. The senators are chosen for four years, one fourth being elected annually at the time of the election of the representatives. Their number cannot be greater than one third, nor less than one fourth, of the number of the representatives. The executive power is vested in a governor, who is elected by the people on the second Tuesday in October, and who holds his office during three years from the third Tuesday in December next following his election; and he cannot hold the office more than nine years in any term of twelve years. The general assembly meets annually at Harrisburgh on the first Tuesday in December, unless sooner convened by the governor. The judicial power is vested in the supreme court, courts of common pleas, an orphan's court, a register's court, a court of quarter sessions of the peace for each county, and in such other courts as the legislature may from time to time establish. The judges of the supreme court, and the several courts of common pleas, are appointed by the governor, and hold their offices during good behaviour. The right of suffrage is possessed by every freeman of twenty-one years of age who has resided in the state two years immediately preceding an election, and within that time paid a state or county tax, assessed at least six months before the election. It may be mentioned, in conclusion, that on the 2d of May 1837, a convention met at Harrisburgh, for the purpose of amending the constitution. What alterations were then made does not appear, but it is not probable that the essential features of the constitution have been materially changed. (R. R. R.)

PENSIONARY, or PENSIONER, a person who has an appointment or yearly sum, payable during life, by way of acknowledgment, and charged on the estate of a prince, company, or particular person.

Grand PENSIONARY, an appellation formerly applied to the first minister of the states of Holland. The grand pensionary was chairman in the assemblies of the states of that province; he proposed the matters to be consulted on, collected the votes, formed and pronounced the resolutions of the states, opened letters, conferred with foreign ministers, and performed various other functions. His business was also to inspect the finances, to maintain the authority of the states, and to see that the laws were observed; and he was perpetual deputy of the states-general of the United Provinces. His commission was, however, only given him for five years, after which it was deliberated whether or not it should be renewed; but there is no instance of its being revoked, and therefore death only put an end to the functions of this important minister.

Pensionary was also the first minister of the regency of each city in Holland. His office was to give his advice in affairs relating to the government, either of the state in general, or of the city in particular; and in assemblies of the states of the province he officiated as speaker in behalf of his city.

PENTACHORD, a musical scale consisting of five conjunct diatonic degrees. Also an instrument of five strings, according to Martianus Cappella, and other writers. Julius Pollux ascribes its invention to the Scythians.

PENTACROSTIC, in *Poetry*, a set of verses so disposed that there are always five acrostics of the same name, in five divisions of each verse.

PENTAMETER, in ancient poetry, a kind of verse, consisting of five feet or metres; and hence the name. The first and second feet may be either dactyls or spondees; the third is always a spondee; and the two last anapests. A pentameter line subjoined to an hexameter constitutes what is called *elegiac* verse.

PENTAPOLIS, a name given to the five cities, Sodom, Gomorrah, Adamah, Zeboim, and Zoar. They were all five condemned to utter destruction; but Lot interceded for the preservation of Zoar, otherwise called *Bela*. Sodom, Gomorrah, Adamah, and Zeboim, were consumed by fire from heaven; and in the place where they stood was formed the Lake Asphaltites, or the Dead Sea.

PENTATEUCH, a word derived from the Greek Πεντατευχος, from πεντε, *five*, and τευχος, an *instrument* or *volume*, and signifying the collection of the five instruments or books of Moses, which are Genesis, Exodus, Leviticus, Numbers, and Deuteronomy.

Some modern critics have disputed Moses's right to the authorship of the Pentateuch. They observe that he always speaks in the third person. "Now the man Moses was very meek above all the men which were upon the face of the earth." "The Lord spake unto Moses, saying," &c. "Moses said to Pharaoh," &c. They think that he would never have thus spoken of himself, but would at least sometimes have mentioned himself in the first person. Besides, according to these critics, the author of the Pentateuch sometimes abridges his narration like a writer who collected from some ancient memoirs, and sometimes he interrupts the thread of his discourse, as, for example, when he makes Lamech the bigamist say, "Hear my voice, ye wives of Lamech, hearken unto my speech; for I have slain a man to my wounding, and a young man to my hurt," without informing us before-hand to whom this is related. Again, when he says, "And the Canaanite was then in the land," these observations cannot be reconciled to the age of Moses, since the Canaanites continued to be the masters of Palestine during the lifetime of the Jewish legislator. The passage from the book of the wars of the Lord, quoted in the book of Numbers (xxi. 14), is supposed to have been inserted afterwards, as also the opening verses of Deuteronomy. The account of the death of Moses, which is at the end of the same book, cannot possibly belong to this legislator; and the same judgment may be formed of other passages, in which it is said that the places mentioned lay beyond Jordan, that the bed of Og was at Ramah to this day, and that the havoth of Jair, or the cities of Jair, were known to the author, though probably they did not receive that name till after Moses's time.

It is also observed, that in the text of the Pentateuch there are some places which are defective; for example, in Exodus (xii. 8) we find Moses speaking to Pharaoh, but the author has omitted the beginning of his discourse. The Samaritan inserts in the same place what is wanting in the Hebrew. In other places the same Samaritan text adds what is deficient in the Hebrew; and what it contains more than the Hebrew seems to be so well connected with the rest of the discourse, that it would be difficult to separate them. Lastly, the same critics believe that they observe certain strokes in the Pentateuch which can hardly have proceeded from Moses, who was born and bred in Egypt; as, for example, what he says of the earthly paradise, of the rivers which watered it and ran through it, of the cities of Babylon, Erech, Resen, and Calneh, of the gold of Pison, of the bdellium, and of the stone of Sohem, or onyx-stone, which was to be found in that country. These particulars, observed minutely, are supposed to prove that the author of the Pentateuch lived beyond the Euphrates; and the same conclusion may be deduced from what he says concerning the ark of Noah, of its construction, of the place where it rested, of the wood with which it was built, of the bitumen of Babylon, and other matters. But in answer to all these objections, we may observe in general, that these books are by the most ancient writers ascribed to Moses; and it is confirmed by the authority of heathen writers themselves, that they are of his writing. Besides, we have the unanimous testimony of the whole Jewish nation, ever since Moses's time, to the same effect. Direct texts of the Pentateuch imply that it was written by Moses; the book of Joshua, and other parts of Scripture, import the same thing; and though some passages have been thought to imply the contrary, yet this is but a modern opinion, and has been sufficiently confuted by several learned men. The Samaritans receive no other Scriptures but the Pentateuch, rejecting all the other books which are still contained in the Jewish canon.

PENTATHLON, in *Antiquity*, was a general name for the five exercises performed at the Grecian games, viz. wrestling, boxing, leaping, running, and playing at the discus.

PENTECONTACHORDON, an old musical instrument of the harpsichord kind, invented by Colonna, a Neapolitan, in the beginning of the sixteenth century. In it, each tone was divided into four parts, and each of these had its own peculiar wire and corresponding finger-key. The distinct wires were 500. This instrument was evidently one of the same hopeless kind that we have mentioned in the article Organ.

PENTECOST, a solemn festival of the Jews, so called because it was celebrated on the fiftieth day after the 16th of Nisan, which was the second day of the passover. The Hebrews called it the "feast of weeks," because it was kept seven weeks after the passover. They then offered the first fruits of the wheat harvest; besides which, they presented at the temple seven lambs of that year, one calf, and two rams, for a burnt-offering, two lambs for a peace-offering, and a goat for a sin-offering. The feast of Pentecost was instituted amongst the Israelites, first, to oblige them to repair to the temple of the Lord, in order to acknowledge his absolute dominion over the whole country, and to offer him the first-fruits of their harvest; and, secondly, that they might call to mind, and give thanks to God, for the law which he had given them from Mount Sinai, on the fiftieth day after their coming out of Egypt.

PENTECOSTE, or Whitsunday Island, a small island in the Southern Pacific Ocean, and one of the great archipelago of the New Hebrides, discovered by Bougainville in 1768.

PENTHESILEA, queen of the Amazons, succeeded Orythia, and gave conspicuous proofs of her courage at the siege of Troy, where she was killed by Achilles. Pliny says that she invented the battle-axe.

PENTLAND or Pictland Frith is a narrow strait of six miles in breadth, between the mainland of Scotland and the Orkney Isles.

PENULA, amongst the ancient Romans, was a coarse garment or cloak worn in cold or in rainy weather. It was shorter than the *lacerna*, and therefore more proper for travellers. It was generally brown, and succeeded the *toga* after the state became monarchical. Augustus abolished the custom of wearing the penula over the toga, considering it as too effeminate for Romans; and the ædiles had orders to suffer none to appear in the circus or forum with the lacerna or penula. Writers are not agreed as to the precise difference between these two articles of dress; but we are told that they were chiefly worn by the lower orders of the people.

PENULTIMA, or Penultimate Syllable, in *Grammar*, denotes the last syllable but one of a word; and hence the antepenultimate syllable is the last but two, or that immediately before the penultimate.

PENUMBRA, in *Astronomy*, a partial shade observed between the perfect shadow and the full light in an eclipse. It arises from the magnitude of the sun's body. For were he only a luminous point, the shadow would be all perfect; but, by reason of the diameter of the sun, it happens that a place which is not illuminated by the whole of the sun does yet receive rays from a part of that body.

PENZANCE, a seaport and market-town of Cornwall, in the parish of Madron and hundred of Penwith, 289 miles from London, and a few from the Land's End. It has a tolerable harbour, which, however, is dry at low water. It is in a district which abounds in minerals, chiefly lead, tin, and copper, with some silver. Mining operations form the chief occupation of the inhabitants. It has a market on Saturday, which is well and cheaply supplied. In virtue of the municipal corporation reform law, passed in 1835, the town annually elects the corporation, consisting of a mayor, six aldermen, and eighteen councillors; and for this purpose it is divided into two wards. The population amounted in 1801 to 3382, in 1811 to 4022, in 1821 to 5224, and in 1831 to 6563.

PEOR, a famous mountain beyond Jordan, which Eusebius places between Heshbon and Livias. The mountains Nebo, Pisgah, and Peor, were near one another, and probably formed parts of the same chain or ridge. It is very likely that Peor took its name from some deity of the same name, which was worshipped there; for Peor, Phegor, or Baal-peor, was known in this country.

PEPLUS was a long robe worn by the women in ancient times. It had no sleeves, reached down to the feet, and was so very fine, that the shape of the body might be seen through it. The Athenians used much ceremony in making the peplus, and in dressing with it the statue of Minerva. Homer makes frequent mention of the peplus of that goddess.

PEPONG, two small islands in the Eastern Seas, near the coast of China. Long. 107. E. Lat. 23. 22. N.

PEPPER, Piper, in *Natural History*, an aromatic berry of a hot quality, and chiefly used in seasoning. We have three kinds of pepper which are at present used in the shops; the black, the white, and the long pepper. Black pepper is the fruit of the *piper*, and is brought from the Dutch settlements in the East Indies. The common white pepper is factitious, being prepared from the black in the following manner. The latter is steeped in sea-water, and then exposed to the heat of the sun for several days, till the rind or outer bark loosens; it is then taken out, and, when it is half dry, rubbed till the rind fall off; the white fruit is next dried, and, lastly, the remains of the rind are blown away like chaff. A great deal of the heat of the pepper is taken off by this process, so that the white kind is fitter for many purposes than the black. However, there is a sort of native white pepper produced upon a species of the same plant, which is much better than the factitious, and indeed little inferior to the black. The long pepper is a dried fruit, of an inch or an inch and a half in length, and about the thickness of a large goose-quill. It is of a brownish-gray colour, and cylindrical in figure, and is said to be produced on a plant of the same genus.

PEPPER Bay, on the west coast of the island of Java, is situated thirty miles south-south-west of Bantam. Long. 105. 40. E. Lat. 6. 24. S.

PEPPERBERG, a town of the island of Java, on the southern coast, seventy-five miles south of Batavia.

PERA, or Pulo Pera, a small island in the Eastern Seas, situated at the entrance of the Straits of Malacca. Long. 98. 36. E. Lat. 5. 54. N.

PERAMBAUCAM, a town of the south of India, in the province of the Carnatic, memorable for the defeat and destruction of Colonel Baillie's force, in September 1780, by Hyder Ali. It is fourteen miles north-east of Conjeveram.

PERAMBULATOR, in surveying, an instrument for measuring distances, and called also odometer, pedometer, way-wiser, and surveying-wheel.

PERCEPTION is a word so well understood that it is difficult for the lexicographer to define it. It has been called the first and most simple act of the mind, by which it becomes conscious of its own ideas. This definition, however, is improper, as it confounds perception with consciousness; although the objects of the former faculty are things without us, and those of the latter the energies of our own minds. Perception is that power or faculty by which, through the medium of the senses, we become cognizant of objects distinct and separate from ourselves, and learn that we are but a small part in the system of nature. See Metaphysics.

PERCH, in land-measuring, a rod or pole of sixteen feet and a half in length. Of these rods, forty in length and four in breadth make an acre of ground. But, by the customs of several counties, there is a difference in this measure. In Staffordshire the perch is twenty-four feet; in the forest of Sherwood it is twenty-five feet, the foot being there eighteen inches long; and in Herefordshire the perch of ditching is twenty-one feet, the perch of walling sixteen and a half feet, and a pole of denshiered ground is twelve feet.

PERCH, a fish. See the article Ichthyology.

PERCOLATION, a chemical operation, which is otherwise denominated filtration.

PERCUSSION, in *Mechanics*, is the impression a body makes in falling or striking upon another, or the shock of two bodies in motion. See Dynamics and Mechanics.

PERCY Isles, a chain of islands in the South Pacific Ocean, distant about thirty miles from the north-east coast of New Holland, and extending from about 21. 32. to 21. 45. S. lat. The name of Percy Islands was given them in 1802 by Captain Flinders, who laid down their respective situations and bearings. The largest island is about thirteen miles in circumference. Turtle abound in these islands, which are visited by the Indians for the purpose of catching them. The large vampyre bat is frequently found here, hanging by the claws with its head downwards.

PEREASLAWL, a city of Russia, in the government of Poltawa, the capital of the circle of the same name. It is at the junction of the rivers Alta and Tracbesh, and was at one period the seat of the ancient Russian princes, and afterwards the see of a bishop, with an extensive diocese. It is still surrounded with earthen walls, and has a cathedral, nine other churches, 1000 houses, and 8000 inhabitants. It is 902 miles from St Petersburg. Long. 31. 27. E. Lat. 50. 4. N.

PEREKOP, a Russian town and fortress at the entrance of the Crimea, to which it is the only practicable approach by land. The town consists of two rows of houses, which line the sides of the great road. Next to its importance as a defensive station, it is of consequence as being the residence of a commission charged with the administration of the salt lakes of the Crimea. It is a great thoroughfare during the summer, more than 20,000 loaded carts of salt passing through it for the supply of the south of Russia. The vast ditches, ramparts, and walls of this place have been recently put in good order. The population consists of Russians, Greeks, Armenians, and Tartars, and, many of the latter being migratory, is very fluctuating.

PERENNIALS, or Perennial Flowers, in *Botany*, a term applied to those plants the roots of which abide many years, whether they retain their leaves in winter or not. Those which retain their leaves are called *evergreens;* but such as cast their leaves are named *deciduous* or *perdifols*.

PERESLAW, a city of Russia, in the government of Vladimir, and the capital of a circle of its own name, is situated on the river Trubesch. It is an ancient place, the see of a bishop, whose diocese is very extensive. It contains 780 houses and seventy wooden booths, with 4380 inhabitants, who are manufacturers of cloth, of silk, and of linen, and have considerable trade with the Ukraine. It is 504 miles from St Petersburg. Long. 37. 32. 25. E. Lat. 55. 15. 30. N.

PERFECT, something to which nothing is wanting, or which has all the requisites of its nature and kind.

PERFECTION, the state or quality of a thing that is perfect. Perfection is divided, according to Chauvinus, into physical, moral, and metaphysical. *Physical* or natural perfection is that by which a thing has all its powers and faculties, and those too in full vigour; and all its parts, both principal and secondary, and those in their due proportion, constitution, and adjustment. In this sense man is commonly said to be perfect when he has a sound mind in a sound body. Physical perfection is by the schools frequently termed ἐνεργητικη, because a thing is enabled thereby to perform all its operations. *Moral* perfection is an eminent degree of virtue or moral goodness, to which men arrive by repeated acts of piety, beneficence, and self-restraint. This is usually subdivided into absolute or inherent, which is actually in him to whom we attribute it; and imputative, which exists in some other, and not in him to whom it is attributed. *Metaphysical*, transcendental, or essential perfection, is the possession of all the essential attributes, or of all the parts necessary to the integrity of a substance; or it is that by which a thing has or is provided with every thing belonging to its nature. This is either absolute, where all imperfection is excluded, as in the Deity, or *secundum quid*, that is, in its own kind, or relative.

PERFUME denotes either the volatile effluvia from any body affecting the organ of smell, or the substance emitting those effluvia; in which last sense the word is most commonly used. The use of perfumes was frequent amongst the Hebrews, and the orientals in general, before it was known to the Greeks and the Romans. In the time of Moses perfumes must have been known in Egypt, since he speaks of the art of the perfumer, and gives the composition of two kinds of perfumes, one of which was to be offered to the Lord upon the golden altar in the holy place, and the other was appointed for the anointing of the high priest and his sons, as also of the tabernacle, and all the vessels that were used in divine service. The Hebrews had likewise perfumes which they employed in the process of embalming their dead. The composition is not known, but it is certain that they generally made use of myrrh, aloes, and other strong astringent drugs, that served to prevent putrefaction (John, xix. 49). Besides the perfumes for these purposes, the Scripture mentions others which the Hebrews used on various occasions. The spouse in the Canticles commends the scent of the perfumes of her lover; and her lover in return says, that the scent of the perfumes of his spouse surpasses the most excellent odours. He names particularly the spikenard, the calamus, the cinnamon, the myrrh, and the aloes, as forming part of those perfumes. The voluptuous woman described by Solomon says that she had perfumed her bed with myrrh, aloes, and cinnamon. The epicures mentioned in the book of Wisdom encourage one another to the luxuriant use of odours and costly perfumes. Isaiah reproaches Judæa, which he describes as a spouse faithless to God, with being painted and perfumed to please strangers: "Thou wentest to the king with ointment, and didst increase thy perfumes." Ezekiel seems to accuse the Jews of having profaned the odours and perfumes, the use of which was reserved to sacred things, by applying them to their own use. Perfumes came afterwards to be very common amongst the Greeks and the Romans, especially those composed of musk, ambergris, and civet. The *nardus* and *malobathrum*, which were held in much estimation, were imported from Syria. The *unguentum nardinum* was variously prepared, and contained many ingredients. *Malobathrum* was an Indian plant. Perfumes were also used at sacrifices to regale the gods, at feasts to increase the pleasures of sensation, at funerals to overpower cadaverous smells and please the manes of the dead, and in the theatres to prevent the offensive effluvia or odour of a crowd from being perceived.

PERGAMO, a town of Asiatic Turkey, once a large capital, but now a place of very little importance. It is situated about fifteen miles from the mouth of the Gramalki. The inhabitants are chiefly Turks, though it has a church belonging to the Christians. Long. 27. E. Lat. 39. 11. N.

PERGAMUS, an ancient kingdom of Asia, formed out of the ruins of the empire of Alexander the Great. It commenced about the year 283 before our era. The first sovereign was one Philetærus, an eunuch, by birth a Paphlagonian, a man of mean descent, and in his youth a menial servant to Antigonus, one of Alexander's captains. He afterwards served Lysimachus, king of Macedonia and Thrace, who appointed him keeper of his treasures lodged in Pergamus. Whilst he held this employment, having fallen under the displeasure of Arsinoe, wife of Lysimachus, she found means to excite a quarrel between him and his master; upon which Philetærus seized on the castle of Pergamus, together with the treasures intrusted to his care, amounting to ninety thousand talents. At first he offered his service, together with his treasure, to Seleucus, the king of Syria; but both Seleucus and Lysimachus dying soon afterwards, he kept possession of the town and treasure until his death, which happened twenty years after his revolt from Lysimachus.

Philetærus left the city of Pergamus to his brother, or, according to some, to his brother's son, Eumenes the First, who, laying hold of the opportunity offered by the dissensions amongst the Seleucidæ, possessed himself of many strongholds in the province of Asia; and, having hired a body of Galatians, defeated Antiochus as he was returning from a victory gained over his brother Seleucus Callinicus. By this victory he obtained possession of the greater part of Asia. But he did not long enjoy his acquisitions; for he died next year of immoderate drinking, a vice to which he was greatly addicted.

Eumenes was succeeded by Attalus the First, nephew of Philetærus, who, on his accession, assumed the title of king of Pergamus. He defeated the Gauls, who seemed desirous of settling in his territory; and, according to Livy, he was the first of the Asiatic princes who refused to pay a contribution to these barbarians. When Seleucus Ceranus was engaged in other wars, he invaded his territories, and conquered all the provinces on the Anatolian side of the Taurus; but was soon driven out of his new acquisitions by Seleucus and his grandfather Achæus, who, entering into an alliance against him, deprived him of all his newly-acquired territories, and even besieged him in his capital. Upon this Attalus invited to his assistance the Gauls who had settled in Thrace; and with their help he not only obliged the enemy to raise the siege of Pergamus, but quickly recovered all the provinces he had lost. After this he invaded Ionia and the neighbouring provinces, where several cities voluntarily submitted to his sway. The Teians, Colophonians, and the inhabitants of Ægea and Lemnos, sent deputies declaring themselves ready to acknowledge him as their sovereign; and the Carsenes, on the other side of the river Lycus, opened their gates to him, having first expelled the governor placed over them by Achæus. Thence he advanced to Apia, and encamping on the banks of the river Megithus, received homage from the neighbouring nations. But here the Gauls, being frightened by an eclipse of the moon, refused to proceed farther; a circumstance which obliged Attalus to return to the Hellespont, where he allowed his allies to settle, giving them a large and fruitful territory, and promising that he would always assist and protect them to the utmost of his power.

Attalus having thus settled his affairs with equal honour and advantage to himself, entered into an alliance with the Romans, and afterwards joined them in their war against Philip, king of Macedonia. Here he had the command of the Rhodian fleet, with which he not only drove the Macedonians quite out of the Greek seas, but having landed his men, he, in conjunction with the Athenians, invaded Macedonia, and obliged Philip to raise the siege of Athens, which he had greatly distressed. For these services the Athenians not only heaped on him all the favours they could bestow, but called one of their tribes by his name; an honour which they had never before bestowed upon any foreigner.

Attalus now attempted to organise a general confederacy of the Greeks against Philip. But whilst he was haranguing the Bœotians with a view to this object, and exhorting them with great vehemence to enter into an alliance with the Romans against their common enemy, he fell down speechless. However, having somewhat recovered, he desired to be carried by sea from Thebes to Pergamus, where he died soon after his arrival, in the seventy-second year of his age and forty-third of his reign.

Attalus was succeeded by his eldest son Eumenes the Second. The latter was exceedingly attached to the Romans, insomuch that he refused the daughter of Antiochus the Great in marriage, lest he should thus be led into a quarrel with that people. He also gave intimation to the Roman senate of the transactions of Ariarathes, king of Cappadocia, who was making great preparations both by sea and land. Nor did Eumenes stop here; for when he saw the war about to break out between Antiochus and the Romans, he sent his brother Attalus to Rome in order to give information of the proceedings of Antiochus. The senate heaped honours both on Eumenes and his brother; and in the war which followed, they gave the command of their fleet to the king of Pergamus, in conjunction with C. Livius Salinator. The victory gained on this occasion was in a great measure owing to Eumenes, who boarded some of the enemy's ships in person, and during the whole action behaved with uncommon bravery. Some time afterwards, Eumenes, having entered the territories of Antiochus with a body of five thousand men, ravaged all the country about Thyatira, and returned with an immense booty. But in the mean time Antiochus invaded Pergamus in his turn, ravaged the whole country, and even laid siege to the capital. Attalus, the king's brother, held out with a handful of men, until the Achæans, who were in alliance with Eumenes, sent a thousand foot and a hundred horse to his assistance. As this small body of auxiliaries were all chosen men, and commanded by an experienced officer, they behaved with such bravery that the Syrians were obliged to raise the siege. At the battle of Magnesia, too, Eumenes behaved with the greatest bravery, not only sustaining the first attack of the enemy's elephants, but driving them back again upon their own troops; which threw the ranks in disorder, and gave the Romans an opportunity of giving them a total defeat, by attacking them opportunely with their horse. In consequence of this defeat, Antiochus was obliged to conclude a peace with the Romans on such terms as they pleased to prescribe; one of which was, that he should pay Eumenes four hundred talents, and a quantity of corn, in recompense for the damage he had done to that prince.

Soon after this Eumenes was engaged in a contest with Prusias, king of Bithynia, who made war upon him by the advice of Hannibal, the celebrated Carthaginian general. But Eumenes, being assisted by the Romans, defeated Prusias in an engagement by sea, and another by land; disasters which so disheartened him, that he was ready to accept of peace on any terms. However, before the treaty was concluded, Hannibal found means to draw into the confederacy Philip of Macedonia, who sent Philocles, an old and experienced officer, with a considerable body of troops, to join Prusias. Eumenes then sent his brother Attalus to Rome with a golden crown, worth fifteen thousand talents, to complain of Prusias for making war on the allies of the Roman people without any provocation. The senate accepted the present, and promised to adjust every thing to the satisfaction of their friend Eumenes, whom they looked upon as the most steady ally they could boast of in Asia. But in the mean time, Prusias, having ventured another sea-fight, gained a complete victory by a contrivance of Hannibal. The greatest part of the ships of Eumenes were burned, several were taken, and the others were so much shattered that they became quite unserviceable. The same year Prusias gained over Eumenes two remarkable victories by land, both of which were entirely owing to stratagems of Hannibal. But, whilst matters were thus going on to the disadvantage of Eumenes, the Romans interfered, and by their deputies not only put an end to the differences between the two kings, but prevailed on Prusias to betray Hannibal; upon which the illustrious fugitive poisoned himself.

Eumenes being thus freed from such a dangerous enemy, engaged in a new war with the kings of Cappadocia and Pontus, in which also he proved victorious. His friendship for the Romans he carried to such a degree of enthusiasm, that he went in person to Rome to inform them of the machinations of Perses king of Macedonia. He had before quarrelled with the Rhodians, who sent ambassadors to Rome to complain of him. But as the ambassadors happened to arrive whilst the king himself was present in the city, the Rhodian ambassadors could not obtain any hearing, and Eumenes was dismissed with new marks of favour. This journey, however, had almost proved fatal to him; for, on his return, as he was going to perform a sacrifice at Delphi, two assassins, sent by Perses, rolled down two great stones upon him as he entered the straits of the mountains. By one of these he was dangerously wounded on the head, and by the other he received a contusion on the shoulder. In consequence of the blows, he fell from a steep place, and thus received so many other bruises, that when he was carried on board his ship it could not well be known whether he was dead or alive. His people, however, finding that he was still alive, conveyed him to Corinth, and from Corinth to Ægina, having caused their vessels to be carried over the isthmus.

Eumenes remained at Ægina till his wounds were cured, which was done with so great secrecy, that a report of his death was spread all over Asia, and even believed at Rome; nay, his brother Attalus was so convinced of the truth of this report, that he not only assumed the government, but even married Stratonice the wife of Eumenes. But in a short time Eumenes convinced both parties of his being alive, by returning to his kingdom. On receiving this intelligence, Attalus resigned the sovereignty in great haste, and went to meet his brother, carrying a halberd, as one of his guards. Eumenes received both him and the queen with great tenderness; only it is said he whispered in his brother's ear when he first saw him, "Be in no haste to marry my wife again till you are sure I am dead."

The king joined the Romans in their war against Perses; but during the course of it he suddenly cooled in his affection towards those allies whom he had hitherto served with so much zeal, and that to such a degree that he admitted ambassadors from Perses, and offered to remain neutral if the latter would pay him a thousand talents, and, for fifteen hundred, to influence the Romans to grant him a safe and honourable peace. But these negociations were broken off, by reason of the distrust which these two kings had of each other. Eumenes would not trust Perses unless he paid him the money beforehand; whilst, on the other hand, Perses did not care to part with the money until Eumenes had first performed what he promised; neither could he be induced to pay the sum in question, though the king of Pergamus offered to give hostages for the due performance of his promise. These negociations were as long as possible concealed from the Romans; but they at length came to be known, after which the republic began to entertain no little jealousy of their old friend, and therefore heaped favours upon his brother Attalus. Eumenes had sent him to Rome to congratulate the senate on the happy issue of the war with Perses, not thinking that his own practices had been discovered. However, the senate, without taking any notice of their disaffection towards Eumenes, entertained Attalus with the greatest magnificence; then several of the senators who visited him proceeded to acquaint him with their suspicions of the king, and desired Attalus to treat with them in his own name, assuring him that the kingdom of Pergamus would be granted him by the senate if he demanded it. Eumenes, alarmed at these proceedings, resolved to proceed in person to Rome, in order to justify himself. But the senate having already condemned him in their own minds, resolved not to hear his vindication, and made an act that no king should be permitted to enter the gates of Rome. Eumenes, who knew nothing of this, set forward on his journey, and landed at Brundusium; but no sooner did the Roman senate receive intelligence of his arrival, than they sent a quæstor to acquaint him with the decree of the senate, and at the same time to apprise him, that if he had any business to transact with the senate, he was appointed to hear it, and transmit it to them, but if not, that the king must leave Italy without delay. To this Eumenes replied, that he had no business of any consequence to transact, and that he did not stand in need of any of their assistance; and, without saying a word more, went on board his ship, and returned to Pergamus. On his return, the Gauls, encouraged by the cold reception which he had met with at Rome, invaded his territories, but were repulsed with great loss. This produced new complaints at Rome, and Eumenes was accused of keeping up a secret correspondence with the king of Macedonia; and the senators having conceived the most implacable hatred against him, seemed absolutely bent on his destruction, when he died, in the thirty-ninth year of his reign, leaving his kingdom and his wife to his brother Attalus.

Attalus, in the commencement of his reign, found himself greatly distressed by Prusias king of Bithynia, who not only overthrew him in a pitched battle, but advanced to the very walls of Pergamus, ravaging the country as he marched along, and at last reduced the royal city itself. The king, however, saved himself by a timely flight, and despatched ambassadors to Rome, complaining of the conduct of Prusias. The latter endeavoured to defend himself, and to throw the blame on Attalus. But, after a proper inquiry was made into the matter, Prusias was found to be entirely in the wrong, and was at last obliged to conclude a peace with his adversary upon the following terms, viz. that he should immediately deliver up to Attalus twenty ships with decks; that he should pay five hundred talents to Attalus within the space of twenty years; that he should pay a hundred talents to some of the other Asiatic nations, by way of reparation for the damages they had sustained from him; and that both parties should be content with what they had possessed before the beginning of the war. The last enterprise in which we find Attalus engaged was against Andriseus, the pretended son of Perses, king of Macedonia, in which he assisted the Romans. After this he gave himself up to ease and luxury, committing state affairs entirely to his ministers; and thus continued till his death, which happened in the eighty-second year of his age, and about 138 years before our era.

Attalus the Second was succeeded by Attalus the Third, the son of Eumenes; for the late king, considering that he only held the crown as a trust for his nephew, passed by his own children in order to give it to him, though he appears to have been by no means worthy of it. He is said to have been deprived of his senses through the violence of his grief for his mother's death; and, indeed, throughout his whole reign, he behaved more like a madman than a person of sane mind. On the death of this tyrant, a will was found, by which he left the Roman people heirs of all his goods; upon which they seized on the kingdom, and reduced it to a province of their empire by the name of Asia Proper. But Aristonicus, a son of Eumenes by an Ephesian courtesan, reckoning himself the lawful heir to the crown, and being by no means satisfied with this usurpation of the Romans, assembled a considerable army in order to maintain his pretensions. The people in general, having been accustomed to a monarchy, dreaded a republican form of government; and having, in consequence, assisted Aristonicus, they soon put him in a condition to reduce the whole kingdom to obedience. The news, however, were speedily carried to Rome; and Licinius Crassus, the pontifex maximus, was sent into the East, with orders to enforce submission to the king's will. Historians take no notice of any forces which were sent along with this commander; from which it is supposed, that he depended on assistance from the Asiatics, who were in alliance with Rome, or from the Egyptians. But when he went thither, he found both the Syrians and Egyptians so reduced that he could not expect any assistance from them. However, he was soon supplied with troops by the kings of Pontus, Bithynia, Cappadocia, and Paphlagonia; but he managed matters so ill that he was entirely defeated and taken prisoner. Those who took him designed to carry him to Aristonicus; but Crassus, not being able to endure the disgrace, would have laid violent hands on himself if he had not been disarmed.

Aristonicus did not long enjoy the fruits of his victory. Indeed he behaved very improperly after it; for, instead of preparing to oppose the next army, which he might have been assured the Romans would send against him, he spent his time in feasting and revelling. But he was soon roused out of his lethargy by Perpenna, the new consul, who having assembled with incredible expedition the troops of the allies, came unexpectedly upon him, obliged him to venture an engagement at a disadvantage, and entirely defeated him. Aristonicus fled to a city called

Stratonice, but was so closely pursued by the conqueror, that the garrison, having no means of supplying themselves with provisions, delivered up their leader, as well as a philosopher named Blosius, who had been the companion and counsellor of Aristonicus. The philosopher behaved with great resolution after being taken, and openly defended his siding with Aristonicus, because he thought his cause just. He exhorted the latter to prevent the disgrace and misery of captivity by a voluntary death; but Aristonicus, looking upon death as a greater misery than any captivity, suffered himself to be treated as his conquerors pleased.

In the mean time, a new consul, named Manius Aquilius, having arrived from Rome, sent a haughty message to Perpenna, requiring him immediately to deliver up Aristonicus as a captive belonging to his triumph when the war should be ended. With this demand Perpenna refused to comply, and his refusal had almost produced a civil war; but this was prevented by the death of Perpenna, which happened soon after the dispute commenced. The Pergamenians, notwithstanding the defeat and captivity of their leader, still held out with such obstinacy, that Aquilius was obliged to besiege, and take by force, almost every city in the kingdom. At last, however, the whole country being reduced, Aquilius triumphed, and the unhappy Aristonicus, being led in chains before his chariot, probably ended his miserable life in a dungeon.

PERGINE, a large but scattered market-town in the Austrian province of Tyrol, and the circle of Trent. It has some cloth manufactures; and near to it there are ironworks. The inhabitants amount to from 7000 to 8000.

PERIAGOGE, in *Rhetoric*, is used where many things are accumulated into one period, which might have been divided into several.

PERIANDER, one of those generally known as the seven wise men of Greece, was the son of Cypselus, tyrant of Corinth. He was born B. C. 665, and died at the age of eighty, B. C. 585. He succeeded his father in the government of Corinth, B. C. 625, and was distinguished at first for the mildness of his disposition; but yielding to the advice given him by Thrasybulus, prince of Miletus, he is said to have become a cruel tyrant. He married Lyside, whom he called Melissa, daughter of Procles, tyrant of Epidaurus, and of Eristheneia, daughter of Aristocrates, the celebrated king of the Arcadians. By her he had two sons, Cypselus and Locophron, the former of whom was an idiot. He struck his wife in a passion, and killed her, at the same time banishing Lycophron to the island of Corcyra, because he dared to bewail the fate of his mother (Herodot. v. 92, iii. 50). In the war between the Athenians and Mytilenæans, B. C. 606, he is said, according to one statement (v. 94, 95), to have been a mediator between the contending parties; but Strabo represents him as having assisted Pittacus. When he began to feel old age advancing, he sent for his son Lycophron; but the inhabitants of Corcyra put him to death, and when Periander failed in inflicting punishment on the authors of this calamity to him, he died of grief. Periander was the author of maxims for the guidance of human life, extending to two thousand hexameter verses. Laertius quotes two letters under the name of Periander, but there seems no good reason for believing that they are genuine. The cruel conduct of Periander made many of the ancients doubt whether the tyrant of Corinth ought to be considered as one of the wise men. It is to be observed, however, that there was a Periander of Ambracia, to whom some give this title. (Diogenes Laertius, *Life of Periander.*)

PERIANTHIUM, from περι, *round*, and ἀνθος, *a flower*, the flower-cup properly so called, or the most common species of calyx, placed immediately under the flower, which is contained in it as in a cup.

PERIAPATAM, a town of the south of India, in the province of Mysore, and towards the borders of the Coorg country. It is the city and domain of an ancient Polygar chief, who was conquered nearly two centuries ago by one of the rajahs of Mysore. The town and fort, and the surrounding country, were laid waste by orders of Tippoo Sultan, when the British army was approaching to it in 1790. In 1799 a battle was fought near this place, between General Stuart's forces and those of Tippoo, in which the latter were totally defeated, and the road to Seringapatam laid open to the victorious army. This district produces about 2000 weight annually of sandal wood, which is conveyed in great quantities to Tellicherry, and thence to China and Nubia. Under the mild government of its present rajah it is recovering from the desolation to which it was exposed. Long. 76. 25. E. Lat. 12. 20. N.

PERICARDIUM, in *Anatomy*, is a membranous bag filled with water, which contains the heart in man and in many other animals. (See ANATOMY.)

PERICARPIUM, from περι, *round*, and καρπος, *fruit*, the seed-vessel, or that organ of a plant which contains the seeds it discharges when ripe. The seed-vessel is in fact the developed seed-bud, and may very properly be compared to the fecundated ovary in animals; for it does not exist till after the fertilizing of the seeds by the male dust, and the consequent fall of the flower. All plants, however, are not furnished with a seed-vessel; and in such as are deprived of it, the receptacle or calyx performs its functions by enclosing the seeds as in a matrix, and accompanying them to perfect maturity.

PERICHORUS, in *Antiquity*, a name applied by the Greeks to their profane games or combats, that is, to such as were not consecrated to any of the gods.

PERICLES, one of the most celebrated of the Greek statesmen, was a native of Athens, and descended, both by the father and mother's side, from the most distinguished families of that city. His father Zanthippus had been concerned in the prosecution of the great Miltiades, and commanded the fleet which defeated the Persians at Mycale, B. C. 479. He married Agariste, the niece of Cleisthenes, the chief of the noble family of the Alcmæonidæ, and the leader of the party which had expelled the Pisistratidæ. It is not known in what year Pericles was born; but as he began to take part in public affairs about B. C. 469, it could scarcely be later than B. C. 490. He died in the autumn of B. C. 431, in the third year of the Peloponnesian war. He studied under the ablest masters that Athens could then furnish. Anaxagoras of Clazomenæ, whose force of understanding and extent of knowledge had acquired him the appellation of Intellect (νους), was the philosopher to whom he was chiefly indebted for the cultivation of his mental powers; but he also derived instruction from Zeno, the founder of the Eleatic school of philosophy, and from Damon, who, professing only music, was considered as the ablest speculative politician that Athens then produced. It is said that the young Pericles resembled much, both in person and voice, the tyrant Pisistratus, and this prevented him for some time from taking any part in public business. But when Aristides was dead, Themistocles banished, and Cimon employed in distant military expeditions, Pericles ventured to make his appearance before the people about B. C. 469; and his eloquence soon enabled him to acquire great influence over them. Although his inclination and feelings might have led him to unite himself to the aristocratical party, his interest and his peculiar talents made him solicit the favour of the people, and he became in course of time the leader of the popular faction. He concurred in the policy of his party in procuring, B. C. 461, the banishment of Cimon; and he also exerted himself to reduce the dignity of the Areiopagus, one of those measures which proved in the end fatal to the Athenian constitution, as it tended to leave the power of the democracy without control.

The increased expenses of the government rendered it necessary that some means should be adopted to improve the income of the state. Pericles proposed that the common treasury of the confederacy, at the head of which Athens stood, should be removed from Delos to Athens. This fund was intended to provide the means of defence against any attack on Greece by a foreign enemy, more particularly by the Persians; and a small yearly assessment was made on each of the confederate states for this purpose. By the will of the Athenians this assessment was increased; and it was determined that the tribunals of Athens should decide all disputes which might arise respecting it. These measures were by no means fair, but the supremacy of Athens by sea made any opposition to its demands at present hopeless. Pericles took part in all the proceedings of his party, although he had not yet acquired the chief control in the state. He was present at the battle of Tanagra, B. C. 457, and distinguished himself the more as he had insisted that Cimon, who had offered his services, should not be allowed to be present on the occasion. The Athenians, however, were defeated, and obliged to retire. In their distress they began to turn their eyes towards Cimon, and it seems to have been thought advisable by the popular party that he should be recalled. Pericles himself moved the decree, B. C. 456, and Cimon returned to Athens, after the expiration of only five years of the term of his banishment. On the death of Cimon in Cyprus, B. C. 449, Pericles was left nearly without a rival; and the nobility thought it necessary that they should bring forward some one to oppose his monopoly of power. Thucydides, son of Melesias, brother-in-law of Cimon, was the person to whom they looked; and, by his abilities, his rank, and his conduct through life, he was certainly entitled to high consideration. The two parties now gradually separated; and they never afterwards coalesced, as they had done under Cimon. A war of words was carried on; but we have little account of it, except the anecdote in which Thucydides candidly acknowledges the superiority of his rival: "When I wrestle with Pericles," he said, "if I throw him ever so decidedly, he can persuade the spectators that he threw me."

It was about this time that some Bœotians, who had been driven from their country in consequence of the Athenian conquest, contrived to get possession of Orchomenos, Chæroneia, and some other towns in that neighbourhood. The Athenian army under Tolmides easily dispossessed them, but on its return it was attacked by another party of exiles at Coronea, B. C. 447, and entirely defeated, with the death of the general. The revolt of Eubœa was the immediate consequence of this defeat; and an army under Pericles had scarcely landed upon the island, when intelligence reached him that the adverse party in Megara had risen, and, with the assistance of Corinth, had overpowered the Athenian garrison, and driven it out of the city. Rumours of an intended invasion of Attica by the Spartans were likewise brought to him. Pericles led back his army from Eubœa, defeated the Megareans, and compelled them to confine themselves within the walls of their city. The attack of the Spartans did not take place till the following spring, and Pericles was believed to have succeeded in bribing the Spartan general Cleandrides to withdraw his troops, as he retreated without striking a blow. Pericles then returned to Eubœa, and the whole island was quickly reduced. The insecure tenure of the Athenian power induced the leading men to seek an accommodation with Sparta, even on conditions that were highly disadvantageous. They had already lost Bœotia, and they now agreed to give up all pretensions to Megara and its territory, to withdraw their garrisons from Trœzen in Argolis, and to afford no assistance whatever to the democratical party in Achaia. On these conditions, a truce for thirty years was concluded, B. C. 445, between the two states. The two parties in Athens were now left at liberty to contend with each other; and as neither was willing to concede any thing to its rival, matters soon came to a crisis, and Pericles succeeded in procuring the banishment, B. C. 444, of Thucydides, by ostracism. From that moment Pericles became the master of Athens and all her dependencies.

The administration of Pericles lasted for fifteen years; and though the seeds of future evils were then plentifully sown, it was a period during which arts, science, and taste reached a perfection which no country has ever surpassed. The policy, not less than the inclination, of Pericles, led him to encourage them, as he found it easier to direct the will and caprices of the sovereign people whilst he excited their admiration by the magnificence of his undertakings. Nothing seems more wonderful than the expedition with which works of stupendous magnitude, and of inimitable beauty, were completed. Many edifices, each of which might have required the labour of many successive ages, were finished during the administration of one prosperous man. The celebrated Phidias was the superintendent to whose taste and skill the whole management was intrusted; and the perfection of design, and even of workmanship, can still be appreciated from the reliques, after a lapse of more than two thousand years. The Parthenon was erected under his eye; and it is by no means unlikely that we may still possess many of his designs in the bas-reliefs which have been transferred from that temple, and now form the most valuable part of the British Museum. Whilst Phidias was employed in executing works of sculpture, Zeuxis and Parrhasius were not less eminent in painting; and Æschylus, Sophocles, and Euripides were calling forth the plaudits of the Athenians by those tragedies which still equally excite our admiration. To this love of the fine arts Pericles added eloquence, such as was fitted to control the passions of a multitude, and an assiduity in public business which never flagged. His integrity, too, was never once called in question; and though he had unlimited control over the public revenues for so long a period, at his death it was found that his private property was even less than when he had received it from his father. Although he was the constant object of satire to the comic poets, and both his person and administration were daily attacked with the severest invectives, he stood firm in the affections of the people, who appear to have never for a moment wavered. It was the chief object of his policy to keep the people either amused or employed; and for this purpose he sent out during peace a squadron of sixty galleys, to exercise for eight months every year. He got rid of the more restless citizens by sending them to various colonies; and it was under his direction that the colony of Thurium, in the south of Italy, was settled, B. C. 443, whither went Herodotus and the orator Lysias.

The first interruption of the peace arose from a dispute between two Asiatic states of the Athenian confederacy, Samos and Miletus, who each claimed the sovereignty over Priene, and it was found impossible to settle the dispute without having recourse to arms. Miletus finding itself worsted, applied to the Athenians for assistance, which Pericles thought proper to grant. His enemies asserted that he was induced to come to this decision by a wish to gratify his mistress Aspasia, a native of Miletus, and one of the most celebrated women of ancient times. (See ASPASIA.) There are sufficient reasons assigned, however, why the Athenians should have interfered, without supposing that Pericles was swayed by any thing but a regard for the interests of his country. He led a considerable fleet, B. C. 440, against the Samians; and, after a nine months' siege, they were compelled to capitulate. Pericles returned with increased popularity, and gained much applause from the eloquence with which he pronounced the funeral oration over those who had fallen in battle. The historian Thucydides does not mention what part Pericles took in those measures which eventually led to the Peloponnesian war; but Plutarch asserts that he was the sole author of that contest. It is said that the people were beginning to show some symptoms of dissatisfaction with his sway, and were listening readily to all accusations against his friends. Phidias had been thrown into prison, and had there died, not without suspicion of poison. Aspasia had been accused and acquitted only through the great exertions of Pericles; and he had found it necessary to recommend to his friend Anaxagoras to retire from Athens for a time, as he was not certain that he could protect him from the malice of his enemies. He knew that upon any critical emergency they must have recourse to him; and, to withdraw the attention of the people from himself and friends, it is said he used every means to fan the flame of war, and to prevent all possibility of an arrangement between the Spartans and Athenians. When war at last was determined on, B. C. 431, Pericles took the whole direction of it on himself, and, thinking it hazardous to venture a battle against the united forces of the Peloponnesians, kept the Athenians within the fortifications of the city. The crowded state of the city, from the peasants who had fled before the enemy, and an insufficiency of food, were the main causes probably of that pestilential disease which broke out with such violence in Athens during the second year of the war, and which is so graphically described by the historian Thucydides (ii.). The Athenians now lost all patience, and wreaked their vengeance upon Pericles, by imposing a fine of fifteen talents on him. At the same time that his influence with the people was thus diminished, he was suffering much from the calamities which had befallen many of his relations, and from a misunderstanding which had for some time prevailed in his own family. He had originally married one of his own relations, but as their dispositions were by no means suited to each other, they had separated, after having two sons, Xanthippus and Paralus. Pericles then lived with Aspasia, towards whom he bore the tenderest regard. Xanthippus was naturally extravagant, and had married a young and expensive wife, who was unwilling to brook the frugality of her father-in-law. They lived therefore in a constant state of irritation with Pericles, and took every opportunity of annoying him. Xanthippus was carried off by the plague, as well as many other of his relations. Pericles bore up against all his misfortunes until the death of Paralus, his last surviving legitimate son, which completely subdued his unbending spirit, and he gave up all attention to public business. It was soon found, however, that no one was capable of filling his place, and the people again solicited Pericles to re-assume the reins of government. To this he acceded; and one of the first favours that he asked was, that they would allow him to enrol a natural son in his tribe, and thereby make him legitimate. In compassion for his misfortunes this was granted, and his son, Pericles, was afterwards one of the ten commanders in the naval engagement of Arginusæ. Pericles was soon after this seized with the plague, and died in the year 428 B. C. to the great regret of the Athenians. He is said to have left nothing in writing, except some public decrees. (Thucydides, *Peloponnesian War;* Plutarch, *Life of Pericles.*)

PERIGEE, in *Astronomy*, that point of the sun or the moon's orbit in which they are at the least distance from the earth. In this sense it is opposed to apogee.

PERIGRAPHE, a word usually understood to express a careless or inaccurate delineation of any thing; but in Vesalius it is used to express the white lines or impressions that appear on the musculus rectus of the abdomen.

PERIGUEUX, an arrondissement of the department of the Dordogne, in France, 775 square miles in extent. It comprehends nine cantons, divided into 126 communes, and contains 91,000 inhabitants. The capital is the city of the same name, which is also the seat of the civil, military, and judicial governments of the department. It stands on the right bank of the river Isle, and is fortified. The streets are narrow and crooked, and the houses old and lofty, so that its appearance is gloomy. It is the see of a bishop, contains 1150 houses, with 8600 inhabitants, and has a public library of 14,000 volumes, a fine old cathedral, and the ruins of a Roman amphitheatre, with some other ancient remains. Long. 0. 37. 56. E. Lat. 45. 11. 10. N.

PERIHELIUM, in *Astronomy*, that part of the orbit of a planet or comet in which it is at its least distance from the sun. In this sense it is in opposition to aphelium.

PERIM, a small island in the Straits of Babelmandeb, destitute of fresh water. It has a good harbour, and is about four miles distant from the coast of Africa. Long. 43. 50. E. Lat. 12. 36. N.

PERIMETER, in *Geometry*, the bounds or limits of any figure or body. The perimeters of surfaces or figures are lines, and those of bodies are surfaces. In circular figures, instead of perimeter, we say circumference or periphery.

PERINDA, a considerable town of Hindustan, in the province of Dowletabad. It is the capital of a district of the same name, has a strong citadel or fort, and belongs to the Mahrattas. Long. 76. 50. E. Lat. 18. 33. N.

PERINGARY, a town of Hindustan, in the Southern Carnatic, and district of Marawas, thirty-two miles east-south-east from Madura. Long. 73. 40. E. Lat. 9. 38. N.

PERINRAPAX, one of the Laccadive Islands, in the Indian Sea. Long. 71. 18. E. Lat. 11. 10. N.

PERIOD, in *Astronomy*, the time occupied by a star or planet in making a revolution round the sun, or the duration of its course till it return to the same part of its orbit. See ASTRONOMY.

PERIOD, in *Music*. See the article MUSIC.

PERIOD, in *Chronology*, denotes a revolution of a certain number of years, or a series of years, by which, in different nations, and on different occasions, time is measured. See CHRONOLOGY.

PERIOD, in *Grammar*, denotes a small compass of discourse, containing a perfect sentence, and distinguished at the end by a point or full stop. Father Buffier observes that there are two difficulties in the use of the period or point; first, in distinguishing it from the colon or double point; and, secondly, in determining justly the end of a period or perfect sentence. It may be remarked, that the supernumerary members of a period, separated from the rest by colons and semicolons, usually commence with a conjunction; yet it is true that sometimes these conjunctions rather begin new periods than supernumerary members of a preceding one. It is the sense of things, and the author's own discretion, that must make the proper distinction in such cases. No rules will be of any service unless this be admitted as one, that when that which follows the conjunction is of as great extent as that which precedes it, it is usually a new period, but otherwise not. The second difficulty arises from this, that the sense appears to be perfect in several short detached phrases, in which it does not seem there should be periods. This is frequent in free discourse, as, *We are all in suspense, make your proposals immediately, you will be to blame for detaining us longer.* Here it is evident that simple phrases have each a perfect sense like periods, and ought to be marked accordingly; but that the shortness of the discourse making them easily comprehended, the pointing is neglected. De Colonia defines a period a short but perfect sentence, consisting of certain parts or members depending one upon another, and connected together by some common vinculum. According to the celebrated definition of Aristotle, a period is a discourse which has a beginning, a middle, and an end, all of them visible at one view. Rhetoricians, in treating of the structure of sentences, consider a period as one of the four parts of composition. The periods allowed in oratory are three: a period of two members, called by the Greeks *dicolos*, and by the Latins *bimembris;* a period of three members, called *tricolos* and *trimembris;* and a period of four, called *quadrimembris* and *tetracolos*.

Period, in numbers, is a distinction made by a point or comma, after every sixth place or figure, and used in numeration for the more readily distinguishing and naming of the several figures or places.

Period, in *Medicine*, is applied to certain diseases which have intervals and returns, to denote an entire course or cycle of such disease, or its progress from any state through all the rest, till it return to the same again.

PERIODIC, or Periodical, something that terminates or comprehends a period; as a periodic month, or the space of time in which the moon completes her period.

PERIOECI (περιοικοι), in *Geography*, such inhabitants of the earth as have the same latitudes, but opposite longitudes, or live under the same parallel and the same meridian, but in different semicircles of that meridian, or in opposite points of the parallel. These have the same common seasons throughout the year, and the same phenomena of the heavenly bodies; but when it is noon-day with the one, it is midnight with the other, there being twenty-four hours in an east or west direction. These are found on the globe by the hour-index, or by turning the globe half round, that is, 180 degrees either way.

PERIPATETICS, philosophers, followers of Aristotle, and supporters of the peripatetic philosophy, called also *Aristotelians*. Cicero says that Plato left two excellent disciples, Xenocrates and Aristotle, who founded two sects, which only differed in name; the former took the appellation of *Academics*, being those who continued to hold their conferences in the Academy, as Plato had done before; the latter, who followed Aristotle, were called *Peripatetics*, from περιπατεω, *I walk*, because they disputed walking in the Lyceum. (See Aristotle and Aristotelian Philosophy.)

PERIPATON, in *Antiquity*, the name of that walk in the Lyceum where Aristotle taught, and whence the name of Peripatetics was applied to his followers.

PERIPETEIA, in the drama, is that part of a tragedy in which the action is turned, the plot unravelled, and the whole concludes.

PERIPHERY, in *Geometry*, the circumference of a circle, ellipsis, or any other regular curvilinear figure.

PERIPHRASIS, or circumlocution (formed from περι, *about*, and φραζω, *I speak*), in *Rhetoric*, a circuitous form of words, much affected by orators, to avoid common and trite modes of expression. The periphrasis is of great use on some occasions; and it is often necessary, to make things be conceived which it is not proper to name. It is sometimes polite to suppress the names, and only to intimate or allude to them. These turns of expression are also particularly serviceable in oratory; for the sublime admitting of no direct citations, there must be a compass taken to insinuate the authors whose authority is borrowed. A periphrasis, by turning round a proper name in order to make it understood, amplifies and raises the discourse; but care must be taken that it be not too much swelled, nor extended *mal à propos*, in which case it becomes flat and languid.

PERIPNEUMONY, Περιπνευμονια (formed from περι, *about*, and πνευμων, *lungs*), in *Medicine*, an inflammation of some part of the thorax, properly of the lungs, attended with an acute fever, and a difficulty of breathing.

PERIRPHANTERIUM, a vessel of stone or brass filled with holy water, with which all those were sprinkled who were admitted by the ancients to their sacrifices. Beyond this vessel no profane person was allowed to pass. We are told by some that it was placed in the *adytum*, or inmost recess of the temple; but others say that it was placed at the door, which indeed seems to be the most probable opinion. It was used both by Greeks and Romans, and has been evidently borrowed, like many other Pagan ceremonies, by the Church of Rome. The Hebrews had also a vessel for purification.

PERISCII, in *Geography*, the inhabitants of either frigid zone, between the polar circles and the poles, where the sun, when in the summer signs, moves only round about them, without setting; and consequently their shadows in the same day turn to all the points of the horizon.

PERISTALTIC, a vermicular spontaneous motion of the intestines, performed by the contraction of the circular and longitudinal fibres of which the fleshy coats of the intestines are composed; by means of which the chyle is driven into the orifices of the lacteal veins, and the fæces are protruded towards the anus.

PERISTYLE, in *Ancient Architecture*, a building encompassed with a row of columns on the inside.

PERITROCHIUM, in *Mechanics*, denotes a wheel or circle, concentric with the base of a cylinder, and moveable together with it round its axis.

PERJURY is defined by Sir Edward Coke to be a crime committed when a lawful oath is administered, in some judicial proceeding, to a person who swears wilfully, absolutely, and falsely, in a matter which is material to the issue or point in question. In ancient times it was in some places punished with death; at other periods it made the false swearer liable to the punishment due to the crime which he had charged the innocent person withal; and at others, again, it subjected him to a pecuniary fine. But though it escaped human, yet it was thought, amongst the ancients in general, that the divine vengeance would most certainly overtake it; and there are upon record many severe inflictions from the hand of God, as monuments of the abhorrence in which this atrocious crime is held by the Deity. The souls of the deceased were supposed to be employed in punishing perjured persons. Even the inanimate creation was thought to take vengeance on this crime. The Greeks supposed that no person could swear falsely by Styx without some remarkable punishment; and that any one guilty of perjury could not enter the cave of Palæmon at Corinth without being made a memorable example of divine justice. In Sicily, at the temple of the Palici, there were fountains called *Delli*, from which issued boiling water, with flames and balls of fire; and we are told that if any person swore falsely near them, he was instantly struck dumb, blind, lame, or dead, or was swallowed up by the waters. But although perjury was thus held in general abhorrence, yet in spite of the credit given to such accounts of divine inflictions, it was so much practised by the Greeks, that *Græca fides* became a proverb. Lovers' perjuries, however, were supposed to pass unnoticed, or to be but very slightly punished with blackness of the nails, a decayed tooth, or some similar diminution of beauty. The ancient philosophers were so afraid of perjury, that even an oath before a judge was never admitted excepting for want of other proof. Plato's precept was, not to administer an oath wantonly, but upon deep grounds, and with the strictest caution. Ulpian gives his opinion thus: "Some are forward to take oaths from a contempt of religion; others, from an extraordinary awe of the Divine Majesty, carry their fear to an unreasonable superstition, so as to make an equitable decision of a judge necessary." "No man will perjure himself," says Aristotle, "who apprehends vengeance from Heaven and disgrace amongst men." Clinias was so very scrupulous, that rather than take even a lawful oath, he suffered the loss of three talents. Perjury, in the time of Philo Judæus, was abominated and capitally punished amongst the Jews; but since that time they have much degenerated, being poisoned by the Talmud, which states, that he who breaks his promissory oath, or any vows he enters into during the year, if he have a mind that they should be ineffectual and invalid, may rise the last day of the year, and say, Whatever promises, oaths, and vows, I may think fit to make in the year following, let them be null, void, and of no effect.[1] The modern Jews employ the same artifice, thinking that they may thus lawfully deceive the Christians.

PERIZONIUS, James, one of the most learned philologists and most judicious critics whom Holland has produced, was born at Dam, in the province of Groningen, in the year 1651. His father, who was both pastor and rector of the school of that place, having, in 1664, been appointed professor of theology at Deventer, young Perizonius there began his studies under Gisbert Cuper, and afterwards went to pursue them at Leyden under George Grævius. Under these two able masters, his progress was extremely rapid; and the death of his father, who intended him as his successor in the chair of theology, leaving him at liberty to follow the bent of his inclinations, he applied himself with fresh ardour to the study of the ancient languages and of history. In the year 1674, he resumed his academical courses, which the war had interrupted, and, when he had completed them, he was appointed rector of the gymnasium at Delft. In 1681, he removed to the academy of Franeker, as professor of eloquence and history, which he taught with such distinction and success, that the curators of the academy, desirous to attach him to the school the reputation of which he had so ably supported, made several additions to his salary. Nevertheless, in 1693, Perizonius accepted the chair of history, eloquence, and the Greek language, in the university of Leyden; and to these subjects he, in 1702, added prelections on the history of the united provinces of the Low Countries. The lustre of his talents shone daily brighter and brighter; and although he discharged with exemplary diligence and fidelity his duty towards his pupils, he every year published some new production calculated to extend his reputation as a philologist. But his assiduous and uninterrupted labours at length undermined his health, which was naturally delicate, and, after languishing for some time in a hopeless condition, he died at Leyden on the 6th of April 1715. Perizonius, though a man of an amiable and obliging disposition, was nevertheless sensitive, and fond of disputation. He engaged in several keen controversies, particularly with Ulric Huber, professor of law at Franeker, on the sense of a passage in the Epistle of St Paul to the Philippians; with Francius, professor of eloquence at Amsterdam; with James Gronovius, on the death of Judas Iscariot; with John Leclerc, on the subject of Quintus Curtius; and with Kuster on the *æs grave* of the ancients. The works of Perizonius all display erudition, but are deficient in order and method. Besides good editions of various authors, he wrote, 1. Animadversiones Historicæ, in quibus quam plurima in priscis Romanarum rerum sed utriusque linguæ autoribus notantur, multa etiam illustrantur atque emendantur, Amsterdam, 1685, in 8vo; 2. Q. Curtius Rufus in integrum restitutus, vindicatus, Leyden, 1703, in 8vo; 3. De Doctrinæ Studiis, nuper post depulsam barbariem diligentissime denuo cultis et desideratis, nunc vero rursus neglectis fere et contemptis, Leyden, 1708, in 8vo; 4. Rerum per Europam sæculo XVI. maxime gestarum Commentarii Historici, *ibid.* 1710, in 8vo; 5. Origines Babylonicæ et Ægyptiacæ, Leyden, 1711, in two vols. 8vo, a work full of curious and interesting remarks on the chronology of Egypt, in opposition to Marsham, Usher, Capell, Pezron, and some other chronologists; 6. Opuscula Minora, Orationes atque Dissertationes varii et præstantioris argumenti, Leyden, 1740, in two vols. 8vo, preceded by a Life of Perizonius, and a catalogue of the manuscripts which he bequeathed to the library of Leyden. Amongst the works edited by this able scholar may be mentioned the History of Ælian, 1701, in two vols. 8vo, and the Minerva of Sanctius, 1714, in 8vo. (A.)

PERIZZITES, the ancient inhabitants of Palestine, who were mingled with the Canaanites. There is some probability that they themselves were Canaanites; but having no fixed habitations, being sometimes dispersed in one country and sometimes in another, they were for that reason called *Perizzites*, which signifies "scattered" or "dispersed." The Perizzites did not inhabit any certain portion of the land of Canaan; there were some of them on both sides of the river Jordan, in the mountains, and on the plains. In several places of Scripture the Canaanites and Perizzites are mentioned as the two principal tribes of the country.

PERM, a town and very extensive government of Russia. The province is situated chiefly in European, but partly also in Asiatic Russia, and is bounded by the government of Viatka on the west, and that of Tobolsk on the east. It has an area of 116,000 square miles, with a population of not more than 1,100,000. It is of a very diversified surface, being intersected from north to south by branches of the great Ural chain. The hills are covered with sand and impenetrable forests, which afford abundant shelter to wild animals, such as the bear, the wild boar, the wolf, foxes, and hares, and the sable and the marten, which are hunted over their farms. It is not a productive country; the summer is warm; but towards autumn, the chill air from the mountains often blights the produce of the harvest, and renders it necessary to import corn for the sustenance of the inhabitants. It has mines of copper, iron, and salt, which it exports to the annual amount of 2000 tons of copper and 10,000 tons of iron; cattle are also exported. The inhabitants are a mixed race, partly Russian and partly of Finnish and Tartar descent. They are principally occupied as shepherds; about 50,000 are employed in the mines. Perm is an inland province. The rivers by which it is intersected are far from the sea; those on the west side of the Ural Mountains flowing into the Kama, which joins the Wolga, and those on the east side falling mostly into the Oby, the outlet of which is the frozen ocean. The inhabitants are partly Christians, partly Mahommedans and Pagans. The town of Perm is situated on the river Kama. It has some neat public buildings, such as two churches, the government-offices, a public school, and an hospital; and carries on an extensive trade in the metals wrought in the surrounding country. The population is 3800. It is 910 miles south by east of St Petersburg, and 720 east-north-east of Moscow. Long. 56. 26. 30. E. Lat. 58. 1. 13. N.

PERMACOIL, a small town and fortress of the south of India, in the province of the Carnatic, situated on a rock from two to three hundred feet in height, but at its base not more than five hundred yards broad. It is exceedingly steep and difficult of access, but was taken by the British, in 1760, under Colonel Coote, who was wounded in the attack. It is seventy-two miles south-south-west from Madras, and twenty miles north-west from Pondicherry. Long. 79. 52. E. Lat. 12. 13. N.

PERMEABLE, a term applied to bodies of so loose a texture as to let something pass through them.

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[1] Tract. iii. part 3, of the Talmud, in the treatise *Nedharim*, chap 4.

Pernambuco.

PERNAMBUCO, a large and important province of Brazil, in South America. It is separated on the south from the provinces of Seregipe and Bahia by the river St Francisco, and from Minas Geraes by the river Carinhenha; on the west it touches on Goyaz; and Paraiba, Seara, and Piauhy bound it on the north. This province is reckoned one of the most flourishing and important in Brazil, and contains more ports than any other, Recife, the capital, being only inferior to Rio and San Salvador in commercial enterprise and industry. Pernambuco extends about six hundred miles in length, but its breadth is much less, being only about fifty miles in the middle, though it widens to about two hundred towards each extremity. Its surface is very unequal, being in some parts mountainous, dry, and barren. In the interior, behind the capital, are immense plains, stretching to a great distance in all directions, although traversed in part by the great middle chain of mountains called the Serra of Borborema, which is described as the most majestic in Brazil. It commences near the sea, in the province of Rio Grande do Norte, and traverses that of Paraiba from north-east to south-west; it then bends to the west, separating that province from Pernambuco and Seara; and, lastly, inclines to the northward, dividing Pernambuco from Piauhy, its name changing as frequently as its altitude varies. In some parts it is rocky and barren, but the greater portion of it is covered with beautiful forests. The whole of this maritime district or canton was included, up to 1810, in the jurisdiction of the ouvidor of Jacobina; but it now goes by the name of the ouvidoria of the sertam of Pernambuco. The most important river of this state, or of any other in Brazil, belonging wholly to the country, is the St Francisco, the largest stream which flows into the Atlantic between the Amazons and the Plata. It rises in the serra of Canastra, in the province of Minas Geraes, in latitude 20° south. After traversing that province from south to north, it bends to the north-east on touching Pernambuco, and flowing along the borders of that state, keeps the same general bearing till within two hundred miles of the sea, when it bends to the south-west, entering the Atlantic in south latitude 11° nearly, after a course of more than one thousand miles. It receives several large streams during the first part of its course, the principal being the Carinhenha, which joins it on the borders of the comarca of Paracatu; the Rio das Velhas, and the Rio Verde, which enter from the right; and the Paracatu, Correntes, and Rio Grande, which flow into it from the left. But no stream of any importance joins the St Francisco after the confluence of the Rio Grande; and so few streams of any description flow from the arid regions of Bahia and Pernambuco, that it may be doubted whether it does not lose more water by evaporation than is supplied by all the paltry affluents which join it during the latter part of its course. After the confluence of the Rio Grande, it bends first to the east, then to the east-south-east, to the aldeia of Vargem Redonda, where the navigation from above terminates. Below Villa Nova the river begins to separate into two large portions, forming a great number of low wooded islands, which are covered by the inundations. This great river, so deep in the interior during the middle part of its course, at length discharges itself by two shallow mouths. The principal one, which is the most northerly, although nearly two miles in width, has not depth enough to allow of the entrance of sumacas, except at high water. In fact, it is navigated by larger boats in the upper than in the lower part of its course.

The climate of Pernambuco is hot and moist in the interior, but more agreeable in the maritime district. Generally speaking, the soil is in many parts rich and fertile, producing cotton, sugar, cocoa, maize, mandioc, and a variety of fruits, medicinal herbs, and vegetables. In the interior, the vast plains already mentioned are covered with luxuriant grass, upon which vast herds of cattle are fed; but these will be described afterwards. The province is divided into two parts by the river Pajehu, a tributary of the St Francisco, namely, the eastern and western districts or cantons. The eastern canton or ouvidoria is subdivided into three comarcas, the northern, central, and southern, the respective head towns of which are Olinda, Recife, and Alagoas. The western, however, has latterly been regarded as a separate province; but if so, it is a very small and unimportant one. The ouvidoria, as containing the capital, demands our first attention. Recife, or, as it is commonly called, Pernambuco, is not to be confounded with Olinda, although some geographers have considered them as forming but one city. It stands upon a flat, and is divided into three parts, a peninsula, an island, and the continent. Recife, or Pernambuco properly so called, is built upon a peninsula, which extends to the southward of Olinda. This is the most mercantile part of the threefold city. St Antonio stands upon an island or sand-bank formed by the arms of the Capibaribe, being connected with Recife by a large bridge almost entirely constructed of stone. The third division of the city is situated on the main land, to the southward of the other two, and is joined to them by a wooden bridge, considered as the largest in Brazil. This portion of Pernambuco is called Boa Vista, where the richer inhabitants reside. The appearance of the country, when Pernambuco is approached by sea, is described as charming. The hills are clothed with wood, gradually rising towards the interior, but none of them is of any considerable height. A singular reef of rocks runs parallel with the coast, and forms the harbour of Pernambuco, vessels being moored between it and the town, safe from every storm. This remarkable reef at the top is scarcely sixteen feet in breadth. To a great depth on the outside it slopes off more rapidly than the Plymouth breakwater, but it is perpendicular within, thus forming a magnificent natural bulwark or breakwater, within which the ocean is as still as a mill-pond. The reef extends beyond the northern boundary of the province to Maranham on the south. In some parts it sinks under water, and there are numberless breaks, by which a communication with the sea is laid open. In breadth it varies from a few fathoms to three quarters of a mile; but everywhere the water is of sufficient depth to admit the vessels mooring close to the rock. There is a bar at the entrance of the harbour, over which, in ordinary tides, there are sixteen feet of water, so that ships of considerable burden may lie there. The entrance into the harbour is very narrow, and close by a fort built on the reef. The hill of Olinda, studded with houses and convents, rises on the right hand, and an island thickly planted with cocoa-nut trees adds considerably to the scene on the left. The principal street of Boa Vista, the last portion of Pernambuco which remains to be described, is broad and handsome, although the ground on which it stands used formerly to be overflowed at high water. A long embankment connects the sand-bank and town of St Antonio with the mainland at Affogados, to the south and west of Boa Vista. The river Capibaribe, so famous in Pernambucan history, discharges its waters into the channel between St Antonio and Boa Vista, after running for some distance in a course nearly from east to west. The city of Pernambuco, which, Mr Southey remarks, "has not inaptly been called the Tripoli of the New World," has continued to be a place of the first consequence from the period of the Dutch conquest; and no other place has derived so great and unequivocal advantages from the growth of the cotton trade. Recife was built by the Dutch under Maurice of Nassau, and by them called Maurice Town or Mauritius. It is situated in latitude 8. 14. south, and longitude 35. 15. west, containing a population of above 60,000 souls. Of these, in 1821 not above a third were whites, and they must now be greatly diminished. The rest consisted of mulattoes and negroes. The former are, generally speaking, more active, more industrious, and much more lively, than the others. Pernambuco long constituted, and still does, we suspect, one of the principal slave-markets in the country; and the callousness and cruelty with which this inhuman traffic has always been carried on, have powerfully contributed to debase the minds and corrupt the morals of the inhabitants. Although within a few degrees of the equator, the climate of Pernambuco is remarkably salubrious, and rendered almost temperate by the refreshing sea-breezes. The comarca of Recife contains only three small towns, besides the capital, and these are too unimportant to require any particular description.

Olinda is situated upon a rocky hill, which, although not very high, is nevertheless the highest in the neighbourhood. Its appearance from the sea is beautiful and prepossessing; but this presage of elegance and grandeur is not realized on a narrow inspection. It is now in a state of great decay, having been deserted for the lower town of Recife. The elevations on which it stands are embosomed in dark woods, which seem coeval with the land itself; and being rent and broken in various directions, they present the most abrupt and picturesque scenery. The population of Olinda may amount to about seven thousand. When it was burned by the Dutch in 1631, it is said to have contained 2500 houses, and about 25,000 inhabitants. It was founded by Duarte Coelho Pereira about the year 1535, but it has continued to decline as Recife has advanced in prosperity. In the comarca of Olinda there are, besides the capital, four other towns, amongst which Goiana and Iguarassu are reckoned considerable places. The latter, distant from Recife seven leagues to the northward, and two from the sea, is one of the most ancient towns of the province. It contains but a scanty population. Goiana, distant about fifteen leagues from Recife, and four from the sea, is a much larger and more flourishing place than the other. It is situated on the banks of a river of the same name, which here bends so considerably as almost to surround the town. Besides sugar, a great quantity of cotton is exported, and there is a large cattle-fair held every Thursday. The planters have the advantage of water-carriage to Recife, as the river for many leagues both to the north and south is one of the largest, and is influenced by the tide even above Goiana. This town, with the surrounding district, is supposed to contain upwards of 20,000 inhabitants. There are several other towns or villages which carry on a considerable trade, and being chiefly situated upon the river Capibaribe, they enjoy ample facilities for communication with the capital.

One of the most important places in Pernambuco is the Island of Itamarca, one of the oldest settlements in Brazil, and formerly a distinct captaincy. It is situated eight leagues to the northward of Recife, at a short distance from the mainland. The Dutch took it in 1633, built a fort on it, and of such importance did it appear to them, that for some time they contemplated removing the seat of government to the island; a plan which was overruled, although Itamarca appears to possess decided advantages as compared with the capital. In the year 1645 Joam Fernandes Vieira, the principal hero of the Pernambucan war, attacked the island, but did not succeed in obtaining possession of it. Subsequent attempts were made, with only partial success, and the Dutch did not surrender the fort until their expulsion in 1654. Itamarca is three leagues in length by about two leagues in breadth; it contains a considerable quantity of excellent land, and, with the exception of the immediate vicinity of Recife, is the most populous part of the province of Pernambuco. As the island produces excellent cane, there are here several sugar-works; and vines were formerly cultivated with great success. The shores are planted with cocoa-trees, amongst which are thickly scattered the cottages of fishermen. One chief source of the wealth to Itamarca is the salt-works, formed upon the sands which are overflowed by the tide at high water. Conception is the oldest town on the island; but the long village of Pillar, situated on its eastern side, is the principal settlement. The ants, the pest of Pernambuco, and indeed of all Brazil, are so numerous here, that whole plantations of mandioc and maize are sometimes destroyed by them. At the northern entrance to the channel of Itamarca is the port of Catuama, the second in importance in the province. Next to it, in the opinion of the inhabitants, is that of Tamandare, ten leagues south-west of Cape St Augustin; but Mr Henderson thinks this port the best of the whole. It is in the form of a bay, with a depth of water sufficient for large vessels, capacious enough to receive a fleet, and securely defended by a strong fort. Cape St Augustin is the only promontory on this part of the coast, and the most eastern land of South America. It has two forts, each of which defends a small port, and stands in latitude 8. 26. south. The comarca or province of Alagos is of comparatively little consideration. The capital, however, which bears the same name, is a place of considerable commerce, and has a population of 14,000 souls. The other towns belonging to Alagos are Maceyo, Porto de Pedras, and Penedo. The latter, the port of the great river St Francisco, is situated about seven leagues from its mouth. It is a flourishing place, and, with the district, contains about 12,000 inhabitants. The river, which is here a mile in breadth, rises only three feet in spring tides; but the town is exposed to injury when the freshes come down.

The western part of the province, or the sertam, is much more extensive than the maritime district; but it is very thinly inhabited, owing to the natural sterility of the soil, and the want of rain, which only falls during thunder showers. It contains several towns, the largest of which, called Barra do Rio Grande, is situated at the confluence of the Rio Grande with the St Francisco. One hundred miles below this town is that of Pilao Arcado, the second place in importance in the sertam. The population of the district has been stated at 5000 souls. Maize, mandioc, and melons are cultivated on the margins of the river, but all the country beyond its immediate vicinity is wild and sterile. There are a great many salt lakes at various distances from the river, and on the margins of these, salt collects, and forms a considerable article of trade. The great, indeed the only business of importance carried on in the sertam is the rearing of cattle, great herds of which range over the immense plains situated on either side of the mountain-chain already mentioned. The Sertanejos, as the inhabitants are called, occupy fazendas or cattle farms of such vast extent, that few know their bounds, although they attempt to calculate them by the hundreds of cattle pastured upon them. Their leagues, as in all other thinly-inhabited tracts, are of deceptive length, sometimes four miles. Their dress consists of jacket, hat, and long pantaloons or leggins, all of brown untanned leather, a tanned goat-skin over the breast, and a pair of coarse cotton drawers or trousers. When on horseback and on a journey, which is often the case, the Sertanejo takes his hammock and portions of his wardrobe along with him, and also carries his farinha, dried meat, and other necessaries. The usual colour of a Sertanejo is dark brown; and the complexion even of those who are born white soon becomes as completely tanned as the dress which they wear. The dress of the women is homely enough, and they are kept in a state of considerable restriction, seldom appearing abroad, or, if they do so, they are never allowed to take any part in conversation. There are no wild cattle in these sertams; but kine are exceedingly plentiful. The religion of the Sertanejos is confined to the observance of certain forms and ceremonies, and to the frequent repetition of a few prayers; but they have great faith in charms, relics, and other things of the same kind. The traffic of the sertam is conducted by pedlars, who give them, in exchange for their live stock, hides, and cheese, various trinkets, articles of luxury, and English cottons, which are now superseding the coarse fabrics of the country. The population of the whole province amounted in the year 1830 to 602,000 souls.

The following is a statement of the quantities of the principal articles of merchandise exported from Pernambuco during the year ending January 1836: Cotton, 52,142 bags; sugar, 17,520 cases, 2846 half cases, 56,996 barrels, and 9180 bags; hides, 91,492; coffee, 300 bags; rum, fifty-eight puncheons; Brazil wood, 1200 quintals; and mandioc 1217 bags; the estimated value of the whole being nearly one million sterling. The number of vessels which entered during the same period was 247, and their total tonnage 47,696. Of these, 179 cleared with cargoes, the rest in ballast. The trade of Pernambuco with Great Britain is more extensive than that with any other country. The goods chiefly sent thither are cotton manufactures, hosiery, lace, and small wares, with earthenware, leather wrought and unwrought, hardwares and cutlery, iron and steel, beaver and felt hats, brass and copper manufactures, apparel, slops and haberdashery, beer, ale, butter and cheese, glass, arms, and ammunition. It appears by the parliamentary papers, from which this statement of the exports is taken, that the trade of Pernambuco is on the increase. (R. R. R.)

PERNICIOUS ISLANDS, a group of islands in the Southern Pacific Ocean, about fifteen miles in circumference, and which were so called by Raggemein, one of whose vessels was wrecked there in 1712. They are supposed to be the Palliser Islands of Captain Cook. Long. 140. 45. W. Lat. 16. S.

PERONNE, an arrondissement of the department of the Somme, in France. It is 465 square miles in extent, and is divided into eight cantons, which are subdivided into 184 communes, containing 98,500 inhabitants. The capital is the city of the same name, situated on the river Somme, in a position marshy and almost inaccessible to an attacking force. It contains a fine market-place, five churches, and 946 houses, with 3760 inhabitants, who manufacture linen goods and tan leather. Long. 2. 50. 35. E. Lat. 49. 55. 30. N.

PERONES, a sort of high shoes, which were worn not only by country people, but also by men of ordinary rank at Rome. In the early times of the commonwealth, they were worn even by senators; but at last they were disused by persons of note, and confined to ploughmen and labourers. They were very rudely formed, consisting of hides undressed, and reached only to the middle of the leg. Virgil mentions the *perones* as worn by a company of rustic soldiers on one foot only.

PERORATION, in *Rhetoric*, the concluding portion of an oration, in which all that the orator had insisted on throughout his discourse is urged afresh with greater vehemence and passion. The peroration consists of two parts; recapitulation, in which the substance of what was diffused throughout the speech is briefly collected, and summed up with new force and weight; and the appeal to the passions, which is so peculiar to the peroration, that the masters of the art call this portion *sedes affectuum*.

PERPENDICULAR, in *Geometry*, is a line falling directly upon another line, so as to make equal angles on each side.

PERPIGNAN, an arrondissement of the department of the Eastern Pyrenees, in France, extending over 557 square miles. It comprehends seven cantons, divided into eighty-five communes, and containing 57,800 inhabitants. The capital is the city of the same name, the see of a bishop, and the seat of the departmental courts of law and boards of government. It stands on the left bank of the river Tet, about ten miles from the Mediterranean Sea. As a frontier place towards Spain, it is strongly fortified, and defended by a citadel. The cathedral is a fine building, but the city generally is not clean or elegant. It contains 2000 houses and 13,200 inhabitants. It has some trade in leather, woollen cloth, wine, corn, and cattle, and considerable contraband intercourse with Spain. Long. 2. 48. 30. E. Lat. 42. 41. 59. N.

PERRAULT, CLAUDE, a celebrated architect, was born at Paris in the year 1613. His father, an advocate of the parliament, caused him to study medicine, anatomy, and the mathematics; and he even took the degree of doctor of physic in the faculty of Paris. But Colbert, the celebrated French minister, having advised him to undertake a translation of Vitruvius, the studies in which he found it necessary to engage in order to understand that writer inspired him with a decided taste for architecture, and gave a new direction to his pursuits. When the Academy of Sciences was established, in 1666, Perrault was admitted a member of this body, and was employed to furnish designs and building-plans for the Observatory. But this edifice, which, with all its merits, is in a heavy style, was far from giving any indication of the talents which Perrault afterwards displayed. His grand work is the palace of the Louvre, the façade of which was designed by him, and is certainly one of the noblest monuments of architecture in the world. The building had been commenced, and even part of the façade raised according to the designs of Lavau. But Colbert, dissatisfied with these, which he justly considered as deficient in grandeur, and unsuitable to the nature of the subject, appealed to the genius of other architects; and Perrault produced a design so superior to those of his competitors, that it immediately obtained a decided preference. Nevertheless, before commencing the work, the king wished to have the ideas of the best artists of Italy; and with this view, Bernini, who then enjoyed a great reputation, both as a sculptor and an architect, was sent for from Rome, and received in France with the greatest distinction. But the pre-eminent merit of Perrault was, notwithstanding, fully recognised; his plans were adopted by the court, although objections had been strenuously urged as to the practicability of their execution; and a model constructed by the artist himself at length removed every doubt on the subject, by proving that the difficulties raised were altogether imaginary, and that the solidity of the fabric might be rendered commensurate with the beauty of the design. Such were the preliminaries of the erection of this monument, which may justly be regarded as the masterpiece of French architecture, and the finest edifice that exists in Paris. Perrault furnished designs for other works, particularly the triumphal arch erected at the extremity of the Rue Saint-Antoine, the foundation-stone of which was laid on the 6th of August 1670; and, in all his works, he displayed that superiority of genius, which was first exhibited in his translation of Vitruvius, particularly in the plates with which it was enriched, and which have ever been considered as masterpieces of their kind. The first edition of this work appeared in 1673, and the second in 1684, in one volume folio; after which the translator published an abridgement in one volume 12mo. To the same author we are likewise indebted for another work, entitled *Ordonnances des Cinq Espèces de Colonnes selon la Méthode des Anciens*, in one volume folio, forming a kind of supplement to the translation of Vitruvius, and containing explanations of several points which had not been touched upon in the notes to that work. Of his other productions the principal are, 1. Essais de Physique, 1680–1688, in two vols. 4to, and four vols. 12mo; 2. Mémoires pour servir à l'Histoire

Naturelle des Animaux, Paris, 1671–1676, in folio; 3. Recueil d'un grand Nombre des Machines de son Invention, for raising and transporting the heaviest weights, Paris, 1700, in one vol. 4to. Claude Perrault assisted his brother Charles in preparing the memoirs relating to the establishment of the Academy of Sciences, and that of Painting and Sculpture, and took a warm interest in the success of that institution. He died at Paris, on the 9th of October 1688, in consequence, it is believed, of having wounded himself whilst dissecting, in the Jardin du Roi, a camel which had died of some contagious disease; and the faculty of medicine caused his portrait to be placed amongst those of their most distinguished members. (A.)

Perrault, *Charles*, the brother of Claude, was born at Paris on the 12th of January 1628, and at the age of eight was placed in the college of Beauvais, where he distinguished himself in scholastic disputation, and in making verses with extreme facility, "indice trompeur d'un talent qui ne mûrit presque jamais." On leaving school, he found that burlesque was in vogue; and a friend having suggested to him the idea of translating the sixth book of the Æneid in the manner of Scarron, he executed the travesty in a manner which attracted the commendation both of Voltaire and of Marmontel. But when his ideas were matured by reflection, he ceased to attach any value to such effusions; and, having completed his studies, he was admitted as advocate, in which capacity he pleaded two causes with success. Colbert, however, soon deprived the law of his services, and, in the year 1664, appointed him first commissary for the superintendence of royal buildings, an office the duties of which he discharged with equal zeal and ability, nobly justifying the confidence of the minister, and regarding himself as the representative of men of letters and of artists at the court. The Academy of Painting, Sculpture, and Architecture, and that of Sciences, were founded on memoirs drawn up by Charles Perrault, who had now become comptroller-general of buildings; and he was admitted into the French Academy in 1671, in the room of the bishop of Léon. But the impracticable character of Colbert having at length wearied out his patience, he retired from his public situation, and, devoting himself to literature, produced his poem entitled *Siècle de Louis XIV.*, which appeared in 1687, and involved him in a war with the learned, by reason of his exalting the modern in comparison with the ancient authors. He defended himself, however, in the *Parallèle des Anciens et Modernes*, which appeared at Paris in 1688, afterwards attracted the notice of Bayle, and excited very considerable attention. One of his principal antagonists was Boileau, who attacked him with great asperity, and, as usual, had all the scoffers on his side; but at length they were, in some measure, reconciled, although, on the part of Boileau, the *amende* was made in a tone which savoured more of contempt than of conciliation. His poem on Painting was, however, generally admired; but his Tales in verse, entitled *Grisélidès*, *Peau d'Ane*, and *Souhaits Ridicules*, are prolix and heavy. Perrault died at Paris on the 16th of May 1703. Besides the works already indicated, he wrote, 1. Recueil des divers Ouvrages en prose et en vers, Paris, 1675, in 4to; 2. Courses de Têtes et de Bagues, faites par le Roi et par les Princes et les Seigneurs de sa Cour, en 1662, Paris, 1669, in folio; 3. Cabinet des Beaux-Arts, *ibid.* 1690, in folio; 4. A Translation of the Fables of Faërne; 5. Memoirs of his Life, for the use of his children; 6. *L'Oublieux* and *Les Fontanges*, manuscript comedies, which, in 1822, passed into the rich and valuable collection of M. de Soleinne. D'Alembert included the éloge of Charles Perrault amongst those of the members of the French Academy (tom. ii. p. 165.) (A.)

PERRON, Jaques Davy du, a cardinal, distinguished by his abilities and learning, was born in the canton of Berne in the year 1556. He was educated by Julian Davy, his father, a learned Calvinist, who taught him Latin and the mathematics; after which, by his own exertions, he became acquainted with the Greek and Hebrew, philosophy, and the poets. Philip Desportes, abbot of Tyron, made him known to Henry III. king of France, who conceived a great esteem for him. Some time afterwards Duperron abjured Calvinism, and embraced the ecclesiastical function in the Catholic Church; and having given great proofs of his wit and learning, he was chosen to pronounce the funeral oration of Mary Queen of Scots. After the murder of Henry III. he retired to the house of Cardinal de Bourbon, and took great pains in bringing back the Protestants to the Church of Rome. Amongst others he gained over Spondanus, who was afterwards bishop of Pamiers. He also contributed to engage Henry IV. to change his religion; and that prince sent him to negociate his reconciliation with the holy see, in which he succeeded. Duperron was consecrated bishop of Evreux whilst he resided at Rome. On his return to France, he wrote, preached, and disputed against the reformed, particularly against Duplessis-Mornay, with whom he had a public conference in the presence of the king at Fontainebleau. In 1604, he was made cardinal by Pope Clement VIII. at the solicitation of Henry IV. who afterwards nominated him to the archbishopric of Sens. The king at length sent him to Rome with Cardinal Joyeuse, in order to terminate the disputes which had arisen between Paul V. and the Venetians. It is said that the sovereign pontiff had such a high opinion of the address of the Cardinal Duperron, that he used to say, "Let us pray to God to inspire the Cardinal Duperron, for he will persuade us to do whatever he pleases." After the death of Henry IV. he retired into the country, where he put the last hand to his work; and, having set up a printing-house, corrected every sheet himself. He died at Paris in 1618; and, after his death, his works were collected and published at Paris in three volumes folio.

PERRUKE, Peruke, or *Periwig*, was anciently a name for a long head of natural hair, particularly such as great care had been taken in adjusting and trimming. Ménage derives the word rather fancifully from the Roman word *pilus*, hair. The Latins called it *coma*, and hence part of Gaul took the denomination of *Gallia Comata*, from the long hair which the inhabitants wore as a sign of freedom. An ancient author says, that Absalom's perruke weighed two hundred shekels. The word is now used for a set of false hair, curled, buckled, and sewed together upon a frame or cawl, anciently called *capillamentum*, or false perruke. It is doubted whether or not the use of perrukes of this kind was known amongst the ancients. It is certain, however, that they used false hair. Martial and Juvenal ridicule the women of their time, for making themselves look young by means of borrowed hair; they scoff at the men who changed their colours according to the seasons, and the dotards, who hoped to deceive the destinies by their white hair. But these oddities do not seem to have had any thing in common with our perrukes, and were at best only composed of hair painted and glued together. Nothing can be more ridiculous than the description which Lampridius gives of the Emperor Commodus's perruke; it was powdered with scrapings of gold, and oiled, if we may use the expression, with glutinous perfumes, to make the powder adhere. The year 1629 is reckoned the epoch of long perrukes; at this time they began to appear in Paris, whence they spread by degrees throughout the rest of Europe.

PERRY, Captain John, a repectable engineer, who resided long in Russia, having been recommended to the Czar Peter whilst in England, as a person capable of serving him on a variety of occasions relating to his new design of establishing a fleet and improving inland navigation. His salary in this service was L.300 per annum, besides travelling expenses and subsistence money on whatever service he might be employed, together with a further reward to his satisfaction at the conclusion of any work he should finish. After some conversation with the czar himself, particularly respecting a communication between the rivers Volga and Don, he was employed on that work for three summers successively; but not being well supplied with men, partly on account of the ill success of the czar's arms against the Swedes at the battle of Narva, and partly by the discouragement of the governor of Astracan, he was ordered, at the end of 1707, to discontinue his operations, and next year was employed in refitting the ships at Veronise, and in making the river of that name navigable; but after repeated disappointments, and a variety of fruitless applications for his salary, he at last quitted the kingdom under the protection of Mr Whitworth, the English ambassador, in 1712. In 1721 he was employed in stopping with success the breach at Dagenham, in which several other undertakers had failed; and the same year he was occupied about the harbour at Dublin, to the objections against which he then published an Answer He was the author of a work on the State of Russia, 1716, 8vo, and an account of the stopping of Dagenham breach, 1721, 8vo; and he died on the 11th of February 1733. These scanty particulars are all that is known of Captain Perry, who seems to have been a man of considerable ability and enterprise.

Perry, the name of a very pleasant and wholesome liquor, extracted from pears in the same manner as cider is from apples.

PERSAIM, or **Bassein**, a town of the Birman empire, and province of Pegu, situated on the river Irrawaddy, which is here called Persaim, and is navigable for ships up to the town. Owing to the inundation of the river, the town is built on piles of wood eight feet from the ground, which admit the tide under them to wash the place, which is the receptacle of every thing that is filthy. The houses are built of wood and mats. During the wars between the Peguans and Birmans this town was burned down, and has never recovered its former splendour. The British obtained, in 1757, a grant of land for the establishment of a factory, but this grant was never ratified by the king. Long. 95. 0. E. Lat. 16. 50. N.

PERSAUMAH, a town of Hindustan, in the province of Bahar, and district of Tirhoot, ninety miles north-east by east of Patna. Long. 86. 32. E. Lat. 26. 1. N.

PERSECUTION means any pain or affliction which one person designedly inflicts upon another; and, in a more restricted sense, it includes the sufferings which the Christians underwent on account of their religion.

Historians usually reckon ten general persecutions; the first of which took place under the Emperor Nero, thirty-one years after our Lord's ascension, when that emperor having set fire to the city of Rome, threw the odium of this execrable act on the Christians, who were consequently wrapped up in the skins of wild beasts, and worried and devoured by dogs, whilst some were crucified, and others burned alive. The second took place under Domitian, in the year ninety-five. In this persecution St John the apostle was sent to the Isle of Patmos, being condemned to work in the mines. The third began in the third year of Trajan, in the year 100 of our era, and was carried on with great violence for several years. The fourth took place under Antoninus the philosopher, when the Christians were banished from their houses, forbidden to show their heads, reproached, beaten, hurried from place to place, plundered, imprisoned, and stoned. The fifth began in the year of our Lord 197, under the Emperor Severus. The sixth began with the reign of the Emperor Maximinus in 235. The seventh, which was the most dreadful persecution that had ever been known in the church, commenced in the year 250, in the reign of the Emperor Decius, when the Christians were in all places driven from their habitations, stripped of their estates, tormented with the rack, and subjected to every species of suffering. The eighth began in the year 257, in the fourth year of the reign of the Emperor Valerian. The ninth took place under the Emperor Aurelian, in the year 284; but this proved very inconsiderable. The tenth began in the nineteenth year of Dioclesian, and in the 303d year of our era. In this dreadful persecution, which lasted ten years, houses filled with Christians were set on fire, and numbers of them were tied together with ropes and thrown into the sea.

But these reiterated and cruel efforts to put down the Christian religion, or at least to check its advancement, proved utterly abortive; perhaps, humanly speaking, they served, in no inconsiderable degree, to accelerate its progress towards the complete triumph which it at length obtained in the reign of Constantine. It has often been remarked, that the blood of the martyrs is the seed of the church, and, in one sense, this is true. Of all the aggressions on freedom of thought and belief committed under the influence of bigotry, fanaticism, or, worst of all, a hard-hearted and unfeeling policy, persecution is the most bootless, short-sighted, and foolish. In every case, it is certain to defeat its own object. It may give even to error a temporary eclat of popularity which it could never otherwise obtain; whilst truth, not only unskathed, but purified, by the fire, issues from the furnace, like gold seven times refined, and presents herself to the eyes of mankind in renovated beauty and glory. Infidel philosophers have told us, that polytheism was naturally tolerant. But the history of the Christian church says No, and proves that Paganism, like every other system of established error, was prone to employ force against evidence, and to persecute where it despaired of convincing.

PERSEES, or **Parsees**, the descendants of a colony of ancient Persians, who took refuge in Bombay, Surat, and the vicinity of those cities, when their own country was conquered by the Mahommedan Arabs. They are a gentle, quiet, and industrious people, beloved by the Hindus, and living in great harmony amongst themselves. The Persees were for a long time but little known. The ancients seldom speak of them, and what they say seems to be dictated by prejudice. On this account, about the end of the seventeenth century, Dr Hyde, who thought the subject both curious and interesting, attempted a deeper investigation of a subject which till then had been but very little attended to. He applied to the works of Arabian and Persian authors, from which, and the relations of travellers, together with a variety of letters received from persons in India, he compiled his celebrated work on the religion of the Persees. Other accounts have been given by different persons, as accident threw information in their way; but the most distinguished is that by M. Anquetil-Duperron, who undertook a voyage to discover and translate the works attributed to Zoroaster.

PERSHORE, a market-town of Worcestershire, in the hundred of the same name, 103 miles from London, on the great road to Worcester. It stands on the river Avon, near its junction with the Bow, by which some internal navigation contributes to the extension of its trade. It is well built, and has a good market, which is on Tuesday, with two fine parish churches; and in the parish there are three chapelries. The population in 1801 amounted to 1573, in 1811 to 1815, in 1821 to 1963, and in 1831 to 2080.

PERSIA.

From the remotest period of antiquity Persia has been celebrated as one of the most powerful empires of the East, the seat of wealth and luxury when Europe was in a state of barbarism. The conquest of Babylon was the commencement of her future greatness; and her warlike monarchs continued their victorious course until they had established a kingdom which extended from the shores of the Mediterranean eastward to the Indus. Their progress westward was resisted by the bravery of the Greeks, by whose united force, under Alexander of Macedonia, Persia was finally subdued, and remained for several centuries under the sway of Greek sovereigns. Her independence was finally re-established under a race of native monarchs about 200 years before the Christian era; and though again subdued by the Moslemin armies, by the Tartar hordes of Genghis Khan and Tamerlane, and by the Afghans, Persia emerged into independence under a native dynasty in 1506, under whose rule the country has ever since remained.

The most fallacious ideas have generally been entertained in Europe respecting the remote countries of the East. These have been famed in all ages for wealth, for boundless magnificence, and for the richest products both of nature and art; and it is remarkable that Persia should have been the peculiar subject of these hyperbolical descriptions, a country of rugged mountains and arid deserts being the least likely to realize them. Nor has the illusion been fully dispelled by modern travellers, several of whom, though they no longer represent Persia as a fairy-land, have yet failed to convey a true impression of its decay and misery. The following account of its geography, its population, commerce, resources, manners, and institutions, is founded on the well-authenticated accounts of those who have recently visited that country, and who have had access to the best sources of information.

The boundaries of Persia have been variously stated, and they have fluctuated with the vicissitudes of war and revolution. The Euphrates and the Tigris, with the mountains of Armenia and Koordistan on the west, the Persian Gulf on the south, the arid and saline deserts on the east, which extend as far as the Indus, and rise into the mountain deserts of Hindu Coosh and Parapamisus, and the Caspian Sea and the mountains of Caucasus on the north, may be considered as the present boundaries of this empire. Geographers have sometimes assigned the Indus as its eastern limit; but the intervening countries of Caubul and Candahar cannot with any propriety be included in the dominions of Persia, having been long independent of her authority; and still less can the southern deserts of Mekran and Beloochistan, which would make the Indian Ocean the southern boundary; since we know, from the most recent accounts of travellers, that they are inhabited by fierce and independent tribes, who have long thrown off their allegiance to the Persian monarchs, and live in wandering communities under their own sheiks.[1]

With the exception of the provinces of Mazanderan and Gheelan, and other parts of less extent, the general aspect of Persia is that of poverty and barrenness. It has been termed a country of mountains; and a large portion of its surface is certainly mountainous, diversified with extensive tracts of desert plains, in which salt is the chief production, and, in a small proportion, chiefly along the banks of the rivers, with beautiful valleys and rich pasture-lands. The valleys are not generally broad, but some are of great length, being often more than a hundred miles. The greater part of the country may be described as a table-land, supported on every side by high mountains. This table-land stretches on a level along a great part of the Persian Gulf and the river Tigris on the south, and, under various appellations, along the Caspian Sea, forming a strip of country which extends about sixty miles to the foot of the Elburz Mountains, and there meets with the plains of Tartary on the north. The height of this plateau, though it was not accurately measured, is estimated by Frazer at 3000 feet; and from its elevated surface the mountainous ranges rise to various heights, sometimes enclosing valleys, or apparently insulating the plain, which often surpasses them in extent. A level country also extends from the mouth of the Indus, along the shore of the Indian Ocean, to the river Euphrates; which is an arid desert, that for a distance of more than twenty degrees does not boast of a single river which is navigable above a few miles from the ocean, and presents to the eye one continued and cheerless succession of sandy plains.[2]

The aspect of the Persian mountains is peculiarly bare and forbidding, rising abruptly from the plain, and presenting nothing to the eye but huge masses of gray rock piled upon each other; and even when they are covered with a little mouldering rock, they are still without either wood or shrubs. If for about two months in spring a scanty verdure clothe their sides, it is scorched by the heat of summer, and the country soon resumes its former barren aspect. Nor is the appearance of the plains more inviting, consisting for the most part of gravel washed down from the mountains, or of other equally unproductive matter, in deep and extensive beds, or of a hard clay, which, where water is wanting, as in most parts of Persia, is bare and barren. "The livery of the whole land," says Frazer, "is constantly brown or gray, except during the two months of April and May." Amongst other disadvantages, Persia labours under a general scarcity of water. The rivers are few and small, and rivulets by no means common, so that irrigation can only be applied to a small portion of the land. "In the best districts," says the above-mentioned traveller, "the small proportion of cultivated land resembles an oasis in the desert, serving by contrast to make all around it more dreary. Plains and mountains are equally destitute of wood: the only trees to be seen are in the gardens of villages, or on the banks of streams, where they are planted for the purpose of affording the little timber that is used in building: they chiefly consist of fruit-trees, the noble chinar or oriental plane, the tall poplar, and the cypress; and the effect which a garden of these trees produces, spotting with its dark green the gray and dusky plain, is rather melancholy than cheering. In picturing, therefore, to the imagination the aspect of a Persian landscape, or indeed the landscape in any of the contiguous countries to the north and east of it, the mind must endeavour to divest itself of every idea that gives interest or beauty to a European scene. There are no beautiful or majestic woods, no verdant plains or grassy mountains, no winding rivers or babbling streams, no parks or enclosures, no castles or gentlemen's seats, no sweet retired cottages, with their white walls glimmering through foliage."[3]

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[1] Morier's Journey through Persia, Armenia, and Asia Minor, p. 49.

[2] History of Persia, by Sir J. Malcolm, vol. i. chap. i.; Morier's Journey, &c. p. 393; Frazer's Narrative of a Journey into Khorassan, p. 162.

[3] Frazer's Narrative, p. 163.

As already mentioned, the provinces of Mazanderan and Gheelan adjoining the Caspian Sea, with parts of Azerbijan and Armenia, form exceptions to this general description. These provinces are divided from each other by the great range of the Elburz Mountains, which are connected with the mountains of Armenia, and with the mighty Caucasus chain, and eastward, by a continuous chain, with the great ridge of the Hindu Coosh. They take an easterly course along the shore of the Caspian Sea, and send various ramifications southward; whilst other elevated ridges spring from the Caucasian Mountains, and penetrate the country in a south-east direction, dividing the provinces of Irak and Kusistan, and extending along the shores of the Persian Gulf, and with other parallel chains farther in the interior, into the province of Mekran. The Caucasian chain forms the barrier between the empires of Turkey and Persia; it occupies the space between the Black Sea and the Caspian; and it is inhabited by barbarous tribes, who owned at any time but an imperfect allegiance to Persia, and who have been now brought chiefly under the more rigorous sway of Russia. The Elburz Mountains present their loftiest face to the interior desert: yet they sweep down in a manner so gradual, that the valleys and ravines which they form are found to contain rich and fertile lands, well watered by numerous rivulets, and well cultivated and peopled. The loftiest peak of this range is Mount Demavend, which rises to the height of 10,000 feet. Here is that remarkable pass, forming a strong barrier against the progress of an invader, which was denominated by the ancients the Caspian Gates, and which for twenty-eight miles is a narrow road between high rocks, through which a single chariot could scarcely pass, and where a handful of men might oppose the advance of an army. These districts are beautifully diversified with wood, water, and mountains, in their most varied forms, and present a luxuriant verdure all the year round. On the northern side of these mountains, the provinces of Mazanderan and Gheelan, and the district of Astrabad, are equally fruitful and productive. Mazanderan is most celebrated for its culture of rice, which is of very superior quality. In the central provinces of Fars, Irak, and Khorassan, the valleys are generally level; in Azerbijan, to the west of the Caspian Sea, they lie between a succession of eminences; and Kurdistan, to the north, is almost one immense cluster of small mountains, intersected occasionally by loftier ranges, on which extend table-lands of great elevation, and subject to extreme cold, as in other parts of Persia.[1] The salt deserts which occur in various parts of the country form one of the most striking objects in its scenery, and may be distinguished from the general dreariness of the country by a saline efflorescence, which is seen glistening in the rays of a fierce sun. This appearance, extending over an immense plain, varied by a black rock here and there protruding from its surface, its image contorted into a thousand wild and varying shapes by the effect of the mirage, which produces the most curious optical illusions on those wide extended level tracts, is a sure indication of the total desolation which reigns around. The most remarkable of these salt deserts is that which extends northward from Helmund, the Elymander of the ancients, a river which takes its rise to the north of Cabul, in the range of hills that divide the country of Beloochistan from Lower Mekran, a distance of about 400 miles. In breadth, from Nooksy north-west to Jalk, it is nearly 200 miles. There are also extensive salt deserts in the provinces of Fars and Kerman, so that a large portion in the very heart of the country is desolate; and another great salt desert extends north-east from the western limit of Khorassan along the provinces of Kashan and Ispahan, and continuous with the deserts of Fars, Kerman, and Seistan; several mountainous projections, however, and cultivated tracts, intervening. This desert occupies a great space in the centre of the country: it extends north-east from the provinces of Ispahan and Fars as far as Tubbus, and with somewhat more frequent interruptions to Toorsheez; and on the east it is encroached on by projections from the more cultivated districts of Furrah, Subsawur, and Herat. The appearance of these deserts is not altogether uniform. In some places the surface is dry, and produces plants which thrive in a salt soil; in others the saline efflorescence is seen on a crackling crust of dry earth; marshes occupy a considerable portion of this country; and there is accumulated in the winter months water, which is evaporated during the heats of summer, leaving a quantity of salt in cakes upon a bed of mud. In some places the soil is a perfectly hard-baked and barren clay; and in others, again, sand abounds, which is formed into hillocks in the shape of waves by the wind, and is so light and impalpable that it is blown aloft in clouds, as in the Arabian deserts, by the violent north-west winds which prevail in summer, and proves dangerous, and frequently fatal, to travellers.[2]

Rivers.

Persia has hardly a single river that can be termed navigable, for the Euphrates and Tigris cannot be considered as running within its territory. The Karoon, which flows into the Euphrates through the province of Kusistan, and the Aras or Araxes in Azerbijan, which flows into the Black Sea, neither of them being considerable streams, are still its two largest rivers. The Helmund cannot with any propriety be termed a Persian river, as it flows eastward of Persia, through the independent territory of Afghanistan.

Soil an
produc

The nature of the soil in Persia may be inferred from the description given by travellers of the aspect of the country. Yet it is extraordinary how vegetation thrives in the country, even with the rudest cultivation, whenever there is the smallest supply of moisture. Morier mentions, that in the plain of Bushire, which stretches into the interior from the Persian Gulf, which all travellers agree in calling a barren land, and which has no other moisture than the dews, and occasionally winter showers, the seed produces one hundred to seven; and that a sprinkling of seed, with the most superficial furrows, returns everywhere in this district abundant produce. The same traveller observed, in his journey from Teheran to Tabriz, several spots where, by the aid of water, the country was one carpet of verdure. Water in Persia is so essential to vegetation, that almost the only species of improvement which is carried on is the construction of subterranean canals, for the purposes of conveying water to lands which are destitute of any natural supply. These canals, when they are finished, are often let at high rents. Frazer mentions one small stream which brought an annual rent of 4000 rupees, equal (the Persian rupee being valued at 1s. 4½d.) to L.375; and another canal, opened by the governor of Kauzeroon, and employed in irrigating a fruit-garden, was rented at five or six times that sum. The products of Persia are, wheat of the finest quality, barley, and other grains. Rice might easily be produced in the southern provinces, were it not for the deficiency of water, of which this grain requires so large a supply. The vine flourishes in several provinces; and the wine of Shiraz has often been highly celebrated, as well as the wines produced from grapes raised upon the side of the Caucasian Mountains. The vines at Shiraz are trained as standard bushes, without any support, and are set, with some attention to regularity, from eight to ten feet asunder. The mulberry is produced in great abundance in the northern provinces of Mazanderan and Gheelan, of which silk is one of the great staples, and also in other parts; and the rich and well-watered plains of Gheelan and Mazanderan yield in abundance the sugar-cane, though the art of refining is not understood in this rude and semi-barbarous country. Amongst the other products of Persia which, being useful, are articles of trade, are gum tragacanth, assafœtida, the plant of which grows in abundance on the plains and hills all around the city of Herat, yellow berries, saffron, henna, but not so fine as that of Egypt; madder roots, which grow wild upon the mountains, and are brought down for sale by the Eelauts and other wandering tribes. Indigo is cultivated near to Kherat and on the Laristan, but is not so fine as the indigo of India, which is largely imported into Persia. The leaf is used for dyeing the beard, a curious fashion in Persia, as in other parts of the East. Cotton is produced to supply the internal consumption; and also hemp and hops. Fruits are produced in the garden-grounds in great abundance and perfection. The date is one of the most important products, being used here, where the climate is extremely hot, as an article of food, in the same manner as in other parts of the East. Those produced at Dalakee, in the province of Fars, are celebrated over the country for richness and flavour. The other fruits are pomegrantes, a luscious fruit here, and much superior to those which are produced in Turkey, some that Morier saw being twelve inches in circumference; sweet and water melons, the shaddock, limes, oranges, for which the climate of the high table-lands is too cold, although they grow to perfection on the plains and on the banks of the Caspian Sea; apples, pears, apricots, pistachio-nuts, walnuts, and some others. Timber is scarce on the arid plains, but in more favourable situations the soil seems well adapted for the growth of wood, and indeed of trees of every description. The mountains of Gheelan, Mazanderan, and Azerbijan are clothed with the finest woods, amongst which are the oak, the beech, the elm, the alder, boxwood, with thickets of wild cherry and thorns, and luxuriant vines climbing up the trunks of the trees, and hanging in wild festoons from the one to the other. These form a striking contrast to the long ranges of naked and barren mountains in the central and southern provinces. In several provinces grows the poppy, from which is made opium of a very fine quality. The liquorice-plant covers the plains of Merdusht, and the neighbourhood of Shiraz. The tamarind, which flourished near the water-courses, and several of the thorny plants that sprinkled the same districts, had been superseded, when Frazer visited these parts, by various aromatic herbs, amongst which a species of fragrant rice was abundant. The most interesting of all the plants is that which yields the gum ammoniac. It resembles hemlock, and rises to the height of from three to six feet. It is remarkable in its season for its rich dark-green verdure; and it is then so full of juice, that on the least scratch it flows in streams to the ground, and congeals on the stalk. It is thus gathered for sale. Such vegetables as carrots, turnips, cabbages, spinach, beet-root, and the like, are common. In the more fertile parts of Persia flowers grow to great perfection and luxuriance; the rose, and every variety of the crocus species, primroses, violets, lilies, hyacinths, and others no less lovely than unknown.[1] Aromatic and thorny plants, and beautiful mountain shrubs, also abound, and clothe the ground in all the rich attire of luxuriant vegetation.

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[1] Sir J. Malcolm's History of Persia, vol. i. p. 5.

[2] Frazer's Narrative, &c. chap. xi.

Notwithstanding the numerous ranges of mountains which intersect the country of Persia, its mineral products are of little value, partly from ignorance of the art of mining, and partly from the general indolence of the inhabitants, owing to the discouragement of tyrannical and rapacious rulers. Morier supposes that coal of a very fine quality must exist in the northern provinces of Mazanderan, by the account he received from the prime minister of a stone which is burned in that province instead of wood or furze, the common fuel in other parts of Persia, and very scarce. He did not learn, however, that any mines were worked. There are, nevertheless, copper mines in the mountains, from which the metal is extracted in such quantities as to render it an article of exportation; and there is little doubt that iron and silver would be obtained if proper means were applied. The mineral production most common in Persia is salt, which, as has been already mentioned, covers vast tracts, and occurs everywhere in great abundance. All the lakes are salt, and every considerable collection of water is impregnated with this mineral. Salt mines are also found in different parts. At Nishapore, in the north, there is a salt-mine consisting of three excavations, in each of which a vein of salt is found from six to eighteen inches in thickness. The salt is beautifully white, and the crystals so clear that Mr Frazer could see distinctly through a mass two inches in thickness, as through a pane of glass. This mine pays a small rent, and the salt is highly esteemed throughout the country. One of the most remarkable productions of Persia is naphtha or bitumen, which is burned by the natives in lamps instead of oil, and also answers all the purposes of pitch, being used in covering the bottoms of the vessels which navigate the Euphrates. It is found in pits three feet in diameter and from ten to twelve feet in depth, which are gradually filled from springs. There is also another species of white naphtha, different from the other, which is found floating like a crust on the surface of the water, and affords a more agreeable light than the black naphtha. A black and liquid petroleum of an agreeable odour flows in small quantity from a mountain in Kerman; it is reserved for the use of the king, and is given away in presents. The mines are carefully sealed and guarded. The northern mountains of Persia contain considerable varieties of valuable marble; and the turquoise stone, which is peculiar to the country, is found in the mountains of Khorassan. The mines which produce this stone were visited by Frazer, who gives a detailed account of their produce, as well as of the very rude manner in which they are worked. The hills in which these stones are found consist of a very red and brown rock. The whole range is deeply tinged with iron. The substances of which the rock is composed are a dead gray earth, heavy hard brown rock, soft yellow stone, and a rock which is pervaded with specular iron-ore. There are five principal mines or pits from which the gem is taken. The mode of management in these mines, which from time immemorial have furnished these highly valued gems, is the most wretched that can be conceived. There is no system whatever, neither skill nor ingenuity, in the mining process; nor any sort of contrivance to economize either labour, or time, or materials. They are not even at the pains to remove the refuse, which soon encumbers and finally puts a stop to their operations; and they break down, quite at random, with picks and hammers, the rock which forms the walls and roofs of the mine, without any attention to preserve the veins in which the gem appears. No shafts or chambers are formed on any regular plan; and if water collects in the mine, they have no means of drawing it off; and, finally, they have no plan for freeing the precious material from the rock in which it is embodied, with the least possible injury.

Climate.

The climate of Persia, in which, according to its latitude, heat should predominate, is considerably modified by the height of the ground; so that, according to Kinneir, the traveller may pass in a few hours from the air of Montpellier to the cold of Siberia.[2] It is intensely cold during the winter; indeed the highest ranges of mountains are covered with snow during a part of the year, and some of the highest peaks throughout the whole year. Demawend, in the Elburz Mountains, which rises to the height of about 10,000 feet, was seen by Morier buried in deep snow in May; and in 1810, Kinneir mentions that the mountains were covered with snow in July. Severe storms also prevail. To the north of Shiraz, especially, cold predominates, insomuch that in the vicinity of Teheran and Tabriz all communication is frequently cut off for several weeks between these cities and the adjoining villages. The cold commences in October, and the winter is ushered in with severe storms of snow. Frazer, after leaving Shiraz, suffered severely from cold in this month. The thermometer fell to twenty-eight degrees, and on the next morning, the 27th of October, to twenty degrees; and in the following month he arrived at Teheran, after encountering so severe a storm of snow that a traveller was carried to a caravanserai frozen to death on his horse. In January, when Frazer was at Nishapore, which is in the north of Persia, in about lat. 36. 25. the thermometer fell during the night to sixteen, nineteen, and twenty degrees, and rose during the day to forty in the shade; and in many parts the temperature varies between the night and the day from sixty-four to twenty-five and twenty-six. The cold, especially to the north of Shiraz, continues, with short intervals of warmer weather, till March or April. At Teheran, which is in the north of Persia, near the Elburz Mountains, Morier describes the progress of the season and the vicissitudes of the temperature. On the 10th of March there was a fall of snow, followed by an intense frost. On the 23d, the mildness of spring was experienced. On the 19th of April the thermometer rose to 82° in the shade. At Shiraz, Morier mentions, that after the middle of June the thermometer was scarcely ever under 100°. It then rose to 105°, 108°, and 110°. "When spring commences," says Sir J. Malcolm, "there is perhaps no spot in the world where nature assumes a more lovely garb than at Ispahan; the clearness of its streams, the shade of its lofty avenues, the fragrant luxuriance of gardens, and the verdant beauty of wide-spreading fields, combine with the finest climate to render it delightful."[1] The regularity of the seasons in this part of Persia is extraordinary, and affords a remarkable contrast to the sudden changes which take place in the northern provinces. In Bushire, to the south of Shiraz, Frazer states the range of the thermometer in July to be from 103° to 109°; but during the night it remained at 90°. About the end of August the weather became cooler, and the thermometer fell to 86° and 87°, and gradually during the day to 75° and 70°. In these southern regions, which include the provinces of Kerman, Laristan, Fars, and Kusistan, situated between the mountains and the shores of the Persian Gulf, the heat is increased by the barren and sandy plains with which this tract abounds. The hot winds known under the name of the simoom or sirocco prevail occasionally, but are not attended with danger, owing to the narrowness of the space between the sea and the mountains. In winter and spring the climate is delightful. It is never very cold; and snow seldom falls on the southern face of the mountains by which these provinces are divided from the north of Persia.[2] Upon the whole, however, the climate of this country, notwithstanding the sudden transitions from heat to cold in some of the provinces, is very healthy; the air is dry, and the atmosphere always clear, so that the brightest polished metal may be exposed to it without being rusted. Nor are the dews insalubrious; whilst at night the planets shine with a lustre unknown in the cloudy skies of the north. It seldom rains, and there are consequently none of those damp and pestiferous exhalations so common in the woody parts of Hindustan. The fertile provinces of Gheelan and Mazanderan, and the district of Astrabad, which are subjected to the periodical visitation of disease, form the only exceptions to this general character. The heavy rains which fall in these mountainous regions, stagnating in the deep forests, turn them into impassable marshes, which becoming putrid from the quantity of vegetable matter that they receive, exhale, during the heats of summer and autumn, a most pestilential vapour, so that the wandering tribes of these countries fly from its influence, and prefer living on the verge of the burning sand, and carrying their water from the distant river, to the least exposure to these noxious effluvia. Those who are forced to remain suffer severely from fevers, putrid as well as intermittent, from dropsies arising from cold, rheumatic affections, palsies, and other maladies. The appearance of the people, however, Frazer remarked, did not indicate either weakness or disease, being remarkably stout and athletic in their persons.

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[1] Frazer, chap. xxiii.

[2] Geographical Memoir of the Persian Empire, p. 21.

The domestic animals of Persia are the camel, the horse, the mule, the ass, the goat, sheep, cow, &c. The Persians are expert and fearless horsemen; and they have different breeds of horses peculiar to the country. The native horse of Persia has been improved, both in strength and bottom, by an admixture of Arabian blood. But the original breed, which is now restored, is a tall, lank, ill-formed, and generally vicious animal, which often vents its rage upon its neighbours or its riders, by kicking or biting them. It is useful, indeed, for hard work; but is not to be compared, for the purposes of riding, with the action and docility of the Arab. There is another race of horses, reared by the Turcoman hordes, not so much distinguished by grace or beauty, as by its hardiness and patience of fatigue, for which it is celebrated all over Asia. It is said to have been crossed with an Arabian breed imported by Nadir Shah. The native horses are noted for size and bone, which appear to be indigenous; but figure and blood they owe to their Arab progenitors. "They have," says Frazer, "large and powerful quarters, resembling those of the English horse; the shoulders are often fine; their legs clean and strong; though generally spare of flesh, what they have is firm and good;" and not being burdened with a load of fat, they support the weight of the rider for an astonishing length of time. Their powers of endurance are almost incredible. They will carry their riders for seven or eight days together at the rate of eighty or a hundred miles a-day. There is also a breed of ponies, fully as remarkable, if not superior to the large horses in their powers of enduring fatigue. Such horses cost a sum of money equal in value to from L.150 to L.200 sterling, and those of the best quality from L.350 to L.400. These horses are used in plundering expeditions; and they are chiefly prized on this account for their hardy qualities. In the parched and sandy tracts of Persia exposed to great heats, camels are preferred, for carrying burdens, to other animals, and they constitute the chief wealth of the inhabitants; but in almost all the other parts of the kingdom mules are more generally used, for which they are well fitted, by their extraordinary strength and activity, and their power of enduring fatigue. Sheep are very abundant in Persia, and constitute the wealth of the wandering tribes; but the latter pay no attention to improve the breed. The dog, though esteemed an unclean animal by the Mahommedans, is yet found so useful that every prejudice has given way; and a very fierce breed is maintained by the wandering tribes, for guarding their flocks and tents, and aiding in their field-sports. The desolate parts of Persia abound in wild animals, amongst which may be numbered the lion, which is seen along the woody banks of the rivers; the tiger, which is more rare; the wolf, the jackall, the hyena, the fox, found in great numbers of a white colour, the porcupine, the mangaush, the wild sheep, the mountain goat, the wild ass, the wild boar, the antelope, and deer in great variety. Tigers are seldom seen, but it is certain that they are to be found, as it is mentioned that the skin of a royal tiger, which was killed in the neighbourhood of Tabriz, was exhibited, and was in possession of Mr Campbell. A tiger was also seen by the shepherds at the time that he was at Tabriz; and one of the Persian princes had gone out to hunt, with a large retinue, in the hope of meeting it. The wild ass is common in Persia, but is extremely shy, and not easily caught. Morier mentions, that one morning in the desert they gave chase to two wild asses; but they distanced the horses at such a rate that they stood still and looked behind at them, "snorting with their noses in the air, as if in contempt of our endeavours to catch them." The hunters sometimes succeed in killing them, but it requires great dexterity and knowledge of their haunts; and then it is only by relays of horses and dogs upon the track which they are known to pursue. The same traveller also observed large herds of antelopes, to which he gave chase, but could never come up except with one big with young; so great is the speed of this beautiful animal. The wild hog abounds in Persia, and is exceedingly fierce. Frazer, along with a party of well-mounted Turcomans, joined in chasing a herd of them; and one being singled out, was assailed with swords and spears, which made no impression on his tough hide; and though wounded by a pistol shot, he continued his flight, until an old man, mounted on a powerful Turcoman horse, rode up and wheeled rapidly round, when the steed, trained to the work, struck the hog on the head with its heels, and tumbled it over dead on the spot. The wild sheep is a very fine animal, bold, portly, and very strong; thick like a lion about the neck and shoulders, and small in the loins; covered with short reddish hair curled loosely about the neck and fore-quarters, and bearing an immense pair of crooked and twisted horns.

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[1] History of Persia, vol. ii. chap. xxiv.

[2] Ibid.

If the face of the country in Persia disappoint the European traveller, his expectations will be still less gratified by the aspect of the towns, which present to him one mass of misery, filth, and ruins; for which, forming his ideas of the eastern towns from what he has read of Ispahan, Bagdad, Shiraz, Bassora, and other cities famed in story, he can scarcely be prepared. He looks in vain for the hum of a crowded population and the bustle of business which animate the cities of Europe. Instead of the road crowded with passengers, vehicles, and an active traffic, bordered with hedgerows and green enclosures, and with gay habitations, he has to thread his way through the narrow and dirty lanes, amidst the ruins of mud walls and old buildings, amongst heights and hollows, and clay pits that produce bricks, and high inclosures that conceal the only verdure the place can boast; till at last he reaches the dilapidated walls of the city, and, entering the gateway, watched by a few squalid guards, he finds himself in a mean bazaar, or more probably in a confusion of mere rubbish. There are no streets, and scarcely a house; for it is only the dwellings of the poor which are seen, the houses of the rich being carefully shrouded from the view by high walls of mud or of raw bricks, very unseemly in their appearance; and outside of these are clustered, with the utmost contempt of order, the houses of the poor. There is scarcely room for a loaded ass to pass between the narrow passages that give access to these dwellings; and as no attempt is made to level the paths, the passenger has to make his way over all impediments, diving into hollows, scrambling amongst ruins, stumbling over grave-stones, or falling into holes, especially at night, as no town is lighted in any of these countries. The bazaars are the only thoroughfares which deserve the name of streets; and these have received merited praise from many travellers, namely, those of Shiraz, the continuous bazaars of Ispahan, which extend for miles, some of those at Teheran, Tabriz, &c., all of which are comparatively spacious, lofty, and built of materials more or less solid; though the majority of Persian bazaars are as wretched as the towns. These bazaars are generally arched over with well-constructed brick-work or clay, or, as in the inferior constructions, with branches of trees. Here, as in India, are collected all the different trades, the smiths, the braziers, the shoemakers, the saddlers, the cloth and chintz sellers, in their own quarter; but confectioners', cooks', apothecaries', bakers', and fruiterers' shops are dispersed in various quarters. Few houses in a Persian town exceed one story; and the general *coup d'œil* presents a succession of flat roofs and long walls of mud, diversified however by gardens, with which the towns and villages are often surrounded and intermingled, and in which are seen the poplar, the cypress, and the oriental plane. Almost all the towns of Persia have some defence, consisting generally of a high mud wall, which is flanked by turrets, and sometimes protected by a deep dry ditch or a rude glacis. Caravanserais are built in every town, for the accommodation of travellers, and are also found at every stage on the principal roads of the kingdom. These edifices are generally constructed of stone or brick, of a square form, and divided in the interior into separate apartments. They are surrounded with high walls and towers, as a defence against the attacks of robbers. The houses are generally built of mud, with terraced roofs; and their inner apartments are usually better than might be expected from their outward appearance. The villages are in general very rudely constructed. The common huts have often, instead of a terrace, a dome roof, in order to avoid the necessity of using wood, which is a very scarce article all over Persia, there being few trees on the arid plains.

Trades and manufactures.

Persia, though it has made no great or general progress in the mechanical arts, has nevertheless been distinguished for those finer manufactures which minister to the luxury of an eastern court. Raw silk is one of the most important staples of Persia, and it is produced more or less all over the country, but chiefly in the provinces of Gheelan and Mazanderan. In the former alone the annual produce amounts to about 900,000 lbs. Silk goods of a very fine quality are manufactured at Yezd; and those of Ispahan, Cashan, and Tabriz are held in great estimation. Silk stuffs are also manufactured in Resht, Lahajan, Fomen, Enzellee, cities of Gheelan, and marts of commerce; and velvets of very great beauty are made at Mushed, and in various other places, namely, Ispahan, Cashan, and Tabriz. Satins also are manufactured, but, as Frazer thinks, not of so fine a quality, and those which are imported from China are preferred. The silk is manufactured into handkerchiefs and other pieces of different lengths and breadths, called alcejahs, dereis, cussabs, peerahums, and taffetas. The city of Shiraz is celebrated for its gold embroideries, though these are now surpassed in other places. Its damasked steel knives and daggers are still esteemed; and it manufactures a good deal of coarse glass ware. All its manufactures have, however, declined since it ceased to be the capital of the country. It has likewise manufactures of arms, cutlery, coarse glass ware, tobacco-pipes, cotton cloths, cotton and woollen stockings, and wine. The cotton goods chiefly manufactured are chintzes or printed cottons, culumcars, peerahur shakees, resembling English long cloths, which have entirely superseded them; kudduks, narrow cloths of a fabric resembling nankeen, and of all colours, manufactured of a fine quality at Ispahan; kherboz, a coarse white cloth of a loose fabric, varying in quality, used chiefly by the poorer classes; and Ispahan stripes, another coarse cloth striped blue, purple, or gray, with other intermediate varieties. The chintzes and prints which are manufactured in many places are coarse both in texture and pattern, and are only used for inferior purposes. They are nearly superseded by the printed cottons of India and Europe, particularly the latter; and it was even said that the home manufacturer had petitioned for protecting duties. But it is not likely that any such measure will be resorted to; and even in this case it would, under the relaxed police of Persia, be easily eluded. Culumcons are distinguished by a pattern of wreathed flowers in gay colours, sparsely strewn upon a white, blue, red, or fawn-colour ground; they are used for inner waistcoats, linings of robes, &c., and are often of very high price. Wool is produced in great abundance all over Persia and the neighbouring countries in which pastoral habits prevail. The best wool is that of the province of Kerman, the mountains of which, hot and arid in summer, and intensely cold in winter, sustain large flocks of sheep and goats, which yield the finest wool. The wool of the sheep is of an excellent quality; and the goats produce a down which grows in winter at the roots of the hair, in the same manner as that of the Thibet or shawl goats, and nearly of as good a quality. This is spun into various fabrics, which almost vie with the celebrated shawls of Cashmere in warmth and softness, as well as in fineness and beauty of manufacture. This fine wool is found not only in Kerman, but more or less over all Khorassan and the countries to the eastward, the mountains of which are favourable to the animals which produce it. The other woollen goods of Persia consist chiefly of carpets, numuds, felted goods, and a variety of fabrics of smaller importance used by the inhabitants as clothing. Many of the chief towns are celebrated for the manufacture of carpets. Those of Kerman, of Yezd, of Boorojird, of the Turcomans, of Khorassan, of Ispahan, and of Azerbijan, are all beautiful, though of different fabrics and patterns. Numuds or fine felt carpets are sometimes of great beauty; but they are dear, and apt to be moth-eaten. Other felted and woollen articles of a coarser quality are manufactured for internal consumption. Swords, fire-arms, and cutlery are manufactured in many of the principal towns. Black handkerchiefs, rather less than 1½ yard square, coarse, and tweelled like Barcelona handkerchiefs, are manufactured everywhere, and serve for the head-dresses of the women.

Trade.

Persia carries on a trade with Turkey, Bagdad, Arabia, and the countries situated on the Persian Gulf. Of the raw silk of Gheelan, amounting, as already stated, to 900,000 lbs., about one fifth part is exported to Constantinople, Aleppo, and the other cities of Asia Minor; about one fifth is manufactured in the cities of Ispahan, Yezd, Cashan, and other towns of Persia celebrated for their silk manufactures; and the remainder is partly purchased by the Russians and carried to Astracan, and partly sent to Bagdad and its vicinity. Persia exports to India specie, dried fruits, dates, tobacco, wine, drugs, assafœtida, sulphur, raw silk, carpets, Kerman shawls, swords, combs, copper, saffron, &c. Horses form a considerable article of export to India. They are sent by sea from Bushire, where they are collected from the breeding districts in the southern provinces of Persia, and from Khorassan and the north-eastern districts by land through Afghanistan and the Punjab; and they serve for mounting the Indian cavalry, and supplying the great private demand for riding horses by the British in India. The imports from India are cotton goods, chintzes, and muslins, from Masulipatam, Moultan, Lucknow, Futtighur, Delhi, and other places; though these have now been in a great measure superseded by the English, French, and German stuffs, introduced from the ports of the Levant, from India, and by way of Russia. Persia receives from India indigo, which comes chiefly by sea, by the way of Bushire, on the Persian Gulf, or by land through the country of Afghanistan, or Balkh, to Bukharia, and thence by Herat to Persia. Spices are also amongst the Indian imports, as well as sugar and sugar-candy, the import of which forms one of the most important branches of trade between the two countries. The province of Mazanderan yields a coarse sugar; and there are many parts of Persia fitted for the growth of this article, yet the country depends chiefly on India for its supply. Gold and silver stuffs from Benares, precious stones, Cashmere shawls, iron, lead, and copper, make up the remaining list of imports. Persia exports to Turkey grain, raw silk, tobacco, paper, cotton, lamb and foxes' skins, carpets, silk and cotton manufactures, Kerman shawls, and salt; and receives in return specie, and European manufactures, brought from the ports on the Levant. From Europe, woollen, cotton, and silk goods are imported, imitation shawls, gold-lace, metal buttons, cutlery, watches, spectacles, spying-glasses, leather, earthen-ware, iron, copper, tin, quicksilver, and other articles. Iron is made in several parts of Persia; but the foreign iron is preferred, and it is imported from Russia, though it is but little used in these countries. Copper in sheets is much used, and is partly imported from Europe through Russia, and partly from India. There is a considerable demand for European silk goods, which are chiefly supplied by the French. Brocades and embroidery are also supplied from France, and Frazer mentions that of these he saw some magnificent samples at Teflis. In chintzes and printed cottons the French and German manufacturers have been more successful than the English in suiting the Persian taste; and every bazaar had, according to the well-informed traveller so often mentioned, a full display of their rich and glaring chintzes, whilst the more sober English goods lay neglected and unseen on the inner shelves. The European trade with Persia, as it is conducted at present, lies under the great disadvantage of an expensive land-carriage. There are various channels through which goods may reach the Persian market. First, they may be sent through Russia, and thence be transported down the river Volga to Astracan, and across the Caspian to the Persian towns of Resht or Astrabad. Accordingly, the countries around Astracan are supplied with the produce and manufactures of Europe by means of this great stream, which affords such facilities for the transport of heavy articles; and it is because Russia cannot herself furnish the necessary supply of goods which are imported from Europe, that the trade is not more considerable. The Russian trade across the Caspian Sea is carried on by twelve vessels, not exceeding a hundred tons, which bring to Astracan the sturgeon cured on the coasts of Gheelan and Mazanderan, besides returns of other Persian produce, and convey Russian or European goods to Resht, Lahajan, Balfroosh, and Astrabad. Secondly, goods may be sent by the Mediterranean to the ports of Trebizond and Redoubt Kaleh, situated at the western extremity of the Black Sea, or to Constantinople; and a considerable quantity of European goods reach Persia by this channel; but in the course of a long route of 1200 miles to Erivan, 200 more to Tabriz, and other 360 to Teheran, in all 1760 miles, they are subjected to an expensive land-carriage, to heavy and arbitrary imposts in their transit through the territories of rapacious chiefs, and to occasional attacks from the predatory banditti of those wild regions, and are consequently brought to Teheran at an expense of sixty-five per cent. The distance from Trebizond to Erivan is only about 140 miles, the road lying across very rugged mountains, though not worse than the roads over which much of the Persian traffic is carried on. The route from Redoubt Kaleh to Teflis, the capital of Georgia, is but 230 miles, and is through a safe country, free from imposts. Teflis, under the protecting government of Russia, has already, like Odessa, risen to be a mart of trade; and caravans regularly travel to Tabriz in eighteen or twenty days. European goods are now sent to this place in considerable quantities, namely, woollen cloths, cotton, printed and plain goods, some hardware articles, some refined sugar from Great Britain, silk and cotton manufactures from Lyons, and embroideries, cloths, &c. from other parts of France. There is another more direct channel through which a supply of European goods may be sent into Persia, namely, by way of Bushire; and, in point of fact, British manufactures to a considerable amount, especially cottons, are imported into this place, and thence conveyed to all the southern cities of Persia, namely, Shiraz, Yezd, Kerman, and Ispahan, whence they find their way still farther inland to Irak, Khorassan, and even to the farther regions of Tartary. These goods are, however, previously sent from Europe to Bombay, and thence to Bushire, being thus burdened with the useless expenses of this double voyage, which would be saved if they were sent directly to the Persian markets. After being loaded at Bushire, the goods must be carried over lofty mountains, by dangerous and wretched roads, before they can reach the market; and they are liable to heavy transit duties at all the towns through which they pass. Goods which are brought to India, and carried into the interior up its navigable rivers, are brought by the overland route through Caubul, Candahar, and Herat, or by Balkh or Bukharia. Certain it is that British goods carried on the backs of mules over dreary mountains find their way to these distant markets; the disadvantage of an expensive land-carriage, and other hazards, being counterbalanced by the great progress which Europe has made in manufacturing industry, and by the extended use of all sorts of ingenious machinery for saving labour, by means of which goods are manufactured and sold cheaper in the most distant markets than they can be furnished by the native workman.

The government of Persia is a pure despotism, which is subject to no control from the influence of laws or manners, and under which every man's life and liberty are at the mercy of the sovereign. He may exalt the lowest subject to the highest rank, or he may degrade, fine, imprison, maim, or put him to death, according to his will or caprice. Nor is this power allowed to remain dormant. The great Shah Abbas put to death an innocent traveller whilst asleep, because his horse startled at him; Aga Mahommed Khan put out the eyes of those who happened to look on his hideous countenance; and the modern history of Persia abounds with examples of horrid tyranny, of nobles and great men about the court being degraded from their rank, cruelly tortured and put to death, and their whole families, slaves and all, involved in their ruin. "The greatest noble in Persia," says Frazer, "is never for a moment secure either in his person or property; if a fit of rage, jealousy, or avarice, of which he is the object, happens to seize his sovereign, a word, a look from the despot subjects him to the most cruel insults; he may be beat, maimed, disgraced like the lowest groom; his person violated in a way degrading to humanity; his wives and daughters delivered to the lust of muleteers (the lowest class in Persia); and the little family honour a Persian can possess may be scattered to the winds, without the unhappy sufferer having the least hope of remedy, without even the event creating the least sensation; it is the shah's pleasure; and if he be firm in his seat, the lives and properties of his subjects are less than the dust beneath his feet." The evils of despotism in Persia are generally aggravated rather than abated by the personal character of the sovereign, which is for the most part cruel and despotic; his early training fostering in him every evil propensity. He is taught from his infancy to consider his subjects as created for his pleasure; he is initiated in the grossest sensuality; and, as if to train him to habits of cruelty, his preceptors are in the practice of taking him to witness executions, which in Persia are conducted with extreme cruelty, as if to steel his mind against humane feelings, and to habituate him to scenes at which other men would shudder. In general the kings of Persia profit by these early lessons; few of them are considerate or merciful; whilst with many, according to Sir J. Malcolm, "the habit of shedding blood becomes a passion, by a brutal indulgence in which, human beings appear to lose that rank and character which belong to their species."[1] It is remarked by Frazer, that all the servants of the king take their tone from him; and that when he is "cruel or merciful, peaceful or warlike, liberal or grasping, his disposition is reflected and multiplied throughout the whole land, down to the lowest ranks of society." Accordingly, throughout the different provinces of the Persian empire, chiefs and governors are everywhere seen improving upon the example of the sovereign; beating, maiming, and rending their property from the unfortunate cultivators who are placed at their mercy. There is no such thing as any protection for life and property in any part of this country; and the officers of government everywhere rob the people, and farther insult and maltreat them if they dare to complain. When the English embassy were travelling through Persia, they were compelled to witness numerous examples of tyranny and cruelty revolting to their feelings. The poor people were compelled to entertain the embassy; and, accordingly, the horses were turned without scruple into the barley fields of the impoverished peasantry. At one place, where one man complained that the produce of the field they were consuming was his sole subsistence, he was taken and severely beaten, and compelled, as Morier observes, to hold their horses as they were eating up his own property before his face. At another village, where the embassy was ordered not to stop, as it had been previously laid under contribution, and could not afford to entertain the embassy for a single day, the officer in charge (the mehmandar) insisted on a contribution in cash; and when they could not raise the money, he forcibly carried away the little furniture that was left in the houses, amidst the lamentations of the women, who were beating their heads, and lifting up their hands to the skies, but who were beaten with sticks and dispersed, by wretches who heeded not their cries.[2] Frazer relates the most shameful instances of the present king's extortion and cruelty. Whilst he was at Teheran, the traveller mentions that one of the courtiers fell under the displeasure of the Shah, who, knowing him to be rich, ordered him to be dragged before him, on a charge of embezzling the public money. During his examination he used some expressions which offended the king, upon which he ordered his officers to bind and to beat him; and in the mean time he began to revile him, and in his rage ordered him to be strangled. When the cord was round his neck, and he was on the ground, the king asked if he would give 100,000 tomauns for his life, to which he replied that he would give all he had; but the answer was considered as equivocal, the cord was tightened, and the blows rained thick upon him, until he acceded to the demand, and, being released, was allowed to return home. His prime minister, also, Hadjee Ibrahim, to whom he owed his elevation to the throne, was on some pretence, for the sake of his wealth it was supposed, degraded, and condemned to lose his eyes. Some expressions escaping him about ingratitude, the tyrant immediately ordered his tongue to be cut out; and under these tortures and persecutions this old and faithful servant of an ungrateful master at length expired. A monarch of Persia acknowledges no obligations but the ritual observances of his religion; and a blind superstition is thus substituted for the moral qualities of mercy, generosity, and justice. Every look being watched by parasites and flatterers, he becomes as impatient of the least opposition as he is insensible to the most devoted service. Distrust and terror reign amongst his courtiers, amongst whom falsehood, dissimulation, and specious show, supply the place of truth and loyalty. They have no means of preserving the royal favour but by flattery and fawning; and hence their whole object is to deceive and pillage, and, if they can with safety and advantage to themselves, to betray their tyrant. The effects of this system may be traced through all ranks about the court, even to the lowest menial. They are, with few exceptions, arrogant, overbearing, unprincipled, treacherous, and abandoned, in the greatest degree. "They stand continually," says Frazer, "on the brink of a dangerous precipice, and would be to be pitied, were it not that the bare-faced and hardened character of their vice" excites a feeling of contempt and detestation. Such is the character given of those who are attached to the various courts, and live in service with great men, including the military and other functionaries. The other two classes into which the population of Persia is divided are, those who live in towns, namely, merchants, shopkeepers, mechanics, and others; those who are engaged in agriculture; and, lastly, the wandering tribes of Eels. The inhabitants of towns are less exposed than others to the tyranny of their superiors, and they are more industrious; and, though far from strict in their morals, they are not so actively vicious. They are, however, cunning, deceitful, false, eager after gain, and cautious and penurious. Being constantly exposed to the most cruel extortion, and to torture, in order to force a disclosure of their wealth, they are forced to resort to the most disingenuous practices in self-defence. The Eels are a wandering race, rude and wild, and subjected only to patriarchal authority. They are, accordingly, impatient of restraint; and being at constant variance with all the neighbouring tribes, they are always engaged in depredations, and consider plunder and robbery as no crimes.

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[1] History of Persia, vol. ii. chap. xxvi.

[2] Morier, Second Journey through Persia, p. 266, 267.

There is no class in Persia subjected to such tyranny and oppression as the farmers and cultivators of the soil. They are exposed to almost continual extortion and injustice; there is no definite limit to the amount of the demands made upon them. When the king demands money from his ministers, they have recourse to the heads of districts, who in their turn apply to the heads of villages, and these last wring it from the cultivators and farmers. Every tax, present, fine, or bribe, from whomsoever demanded in the first instance, ultimately falls upon them; so that the only measure of these demands is the ability to pay on the one hand, and the power to extort on the other. Yet there are exceptions to this uniform system of oppression; and when travellers have been admitted to view the Persian farmers in their houses and with their families, a degree of comfort and comparative plenty have been discovered, not quite compatible with the general tale of misery that was told. The explanation of this, however, is, that the peasantry and farmers sometimes contrive to baffle the vigilance of their oppressors, and to place beyond their reach a portion of their produce sufficient to insure to them a comfortable subsistence. They are described, however, as a race degraded by tyranny; as being devoid of truth, frankness, or honesty; treacherous, deceitful, deficient in gratitude and every other amiable disposition. The cruel acts of their rulers have familiarized them to deeds of blood; they set little value upon human life, and are apt to draw the knife in all their quarrels. They are easily inflamed into passion, and when under its influence they are careless of the result, the meanest inhabitant often venting imprecations against his superiors, and even against the king himself, which pass without any further notice than a few blows. They are active and intelligent, and these seem to be the only valuable qualities which they possess. They are also light-hearted, better humoured, and less grave and austere, than most of the other Asiatics; but their falsehood is proverbial; indeed habits of lying are so inveterate, that untruths flow as it were spontaneously from their tongue, even when no apparent motive exists. All travellers agree in this as one general characteristic of the Asiatics; the sure mark of the low state of civilization in that great continent. The politeness of the Persians, for which they have been so much famed, seems to consist more in the observance of a troublesome routine of ceremonies, and the use of complimentary language in all the forms of eastern hyperbole, than in any real courtesy. A Persian will say to a stranger that he is his slave, that his house and all that it contains, his horses, equipage, &c. all are at his service; but no one understands this in any other sense than an unmeaning form, which encumbers the intercourse of society, without refining it. In their persons the Persians are described as being handsome, active, and robust; lively in their imaginations, and of quick apprehension, but without any moral quality to attract esteem. The effects of the cruel despotism under which Persia groans, in thus degrading the character of the people, and also in checking the progress of science and of every useful art, are truly melancholy. The insecurity of life and property is the dead-weight which oppresses the country. It represses the efforts of industry; it paralyses the powers of invention, and every ingenious improvement; for no man will sow where he is not sure of reaping, or will task his ingenuity to produce what he may be deprived of the next hour. Frazer mentions the case of an ingenious manufacturer of porcelain, whose fame quickly spread till it reached the court, whence a message was despatched for him, that he might make china for the Shah. He well knew that he would receive nothing for his labour, and that he would, moreover, be forced to make china for all the nobles belonging to the court. He accordingly went to court, and mustering all the money he was worth, offered it as a bribe to the minister if he would report to the king that he was not the person that made the china, and that he had run away, nobody knew whither. The ruse succeeded. The minister sent his discharge to the man, who vowed that he would never make a bit of china, or attempt any other improvement, as long as he lived. It is a common practice to kidnap the best workmen in all trades for the use of the court and great men of the provinces, who never pay the workmen they employ. Hence every one avoids the reputation of excellence, except in the commonest trades; and thus, under the benumbing influence of this frightful despotism, improvement is nipt in the bud, and every useful invention is discouraged. There is no outlay of labour or of capital in expectation of any profitable return. No speculation is hazarded which promises any future advantage. No provision is made of any article, not even food, beyond the immediate demand. The people are reckless and indifferent to all but the passing hour, living from day to day uncertain whether they may have life or property on the morrow. No trees are planted; no extensive improvement takes place on the face of the ground; no public buildings of any solid materials are erected; no one thinks of posterity, but only how he can accommodate himself. All classes, however, are eager to accumulate money, as the means of support, or of purchasing safety in any emergency; and this desire is matured at last into an insatiable avarice, which is nowise scrupulous about the means of its gratification.

The king of Persia has a great variety of personal duties to perform. He gives audience at an early hour of the morning to his principal ministers and secretaries, who make reports of all state transactions, and receive his commands. He holds a public levee, which is attended by the princes, ministers, and officers of his court, at which rewards are distributed and punishments awarded. He then gives one or two hours to his personal favourites, or to his ministers. After the morning is past he retires to his inner apartments, where he is shrouded from observation. In the evening he holds a levee, and transacts business with his ministers and principal officers of state. This, however, is rather a sketch of what his employments ought to be, than of what they are. They may be interrupted by indolence or the love of pleasure; and the labour of business may be devolved, if such be his will, upon his favourites.

The business of the prime minister depends greatly on the personal favour of the king, which if he enjoys, he exercises great influence over all the branches of the government. Besides the chief ministers, the secretaries of state preside over the different offices or chambers of accounts; and regular accounts are kept of the receipts and disbursements of the whole kingdom.

The law of Persia, as in all other Mahommedan countries, is founded upon religion as contained in the Koran, and also upon tradition. Its rules are accordingly extremely vague and imperfect, and are administered by the priesthood, who often pronounce the most corrupt decisions, although the law, deriving its sanctions from religion, forms the only defence, feeble as it is, which the people possess against the violence and rapacity of power. Many cases are also decided by the law of custom or tradition, which, having reference to local as well as to common usages, varies in different parts of the empire, and is if possible a still more vague and imperfect code than the written law of the Koran. The ecclesiastical order in Persia, as in all other countries, eagerly grasping after power, insist that the law which they administer, being divine, should take cognizance of all cases. But the ordinary courts of common law, supported by the state, have succeeded in limiting their jurisdiction to cases of religious ceremonies, cases of inheritance, marriage, divorce, contracts, sales, and all civil matters; reserving to the ordinary courts the decision of criminal cases, such as murder, theft, fraud, breaches of the peace, and other offences. The order of priests have great influence in Persia. Before the reign of Nadir Shah, the whole power centred in the chief pontiff, who was deemed the vicar of Imaum, and engrossed vast wealth and influence. At the death of this high priest, no successor was appointed by Nadir Shah, who, besides, seized the treasures of the priesthood, in order to pay his troops. His grandson and successor appointed two persons to this high dignity, with a view of diminishing, by dividing, their power and influence. These priests are called Mooshtaheds; and there are now seldom more than three or four of this high dignity in Persia. They fill no office, receive no appointment, and have no specific duties, but are called by the voice of the public, from their superior learning, piety, and virtue, to be their guides in religion, and their protectors against oppression; and Sir John Malcolm observes, that they receive from the people a degree of respect and reverence to which the proudest kings would in vain lay claim. Their conduct generally agrees with the sacred character to which they owe all their importance; as they know, that in deviating from the strictest purity, they would lose all their influence, and could no longer expect to see the monarch courting popularity by walking to their humble dwellings, and placing them in the seat of honour when they pay a visit to his court. This order of priests exercise an important influence on the administration of the written law. Cases are constantly submitted to their superior knowledge; and there is no appeal from their sentence, except to a priest acknowledged to be superior in sanctity and in learning. The sacred character of these priests gives an authority to the decrees of the tribunals over which they preside, which the monarch is forced to respect. They are often effectual intercessors for mercy to the guilty; their habitations are considered as the sanctuaries of the oppressed; and "the hand of despotic power," says Sir John Malcolm, "is sometimes taken off a city, because the monarch will not offend a mooshtahed, who has chosen it for his residence, but who refuses to dwell amidst violence and injustice." Next in rank to these high priests, there is the Shaik-ul-Islam, literally the "elder or chief of the faith," who acts as a supreme judge in the court of written law. One of this class resides in all the principal cities; and under him is the cauzee, who has a council of moolahs or learned men as his assessors. In the lesser towns there is only a cauzee, from whom there lies an appeal, in cases of intricacy, to the cauzee of the larger towns, and finally to the supreme judge of the provincial capital. But, as in all countries, such as Persia, where there is no enlightened morality, and no control of public opinion, justice is venal and corrupt; the administration of the written law by the priests is extremely imperfect, and inadequate to its ends, insomuch that the suitor is deprived of every hope of justice; and it is only the administration of the customary law that offers any security, however imperfect, for justice between man and man. Even here, however, the administration of justice varies with the character of the reigning despot; and the judges in all their various gradations, from the king's lieutenants, the rulers of provinces, governors of cities, lay managers of towns, managers and collectors of districts, and heads of villages, aided by the officers under their authority, are active and just, or corrupt and cruel, as the monarch happens to be vigilant or virtuous, avaricious or tyrannical. Moral principle and the power of public opinion afford the only security for the pure administration of justice; and among public men trained in this school, the corruption of a judge is never so much as heard of. But such wholesome restraints do not exist in Persia. The European ideas of honour are scarcely known amongst any class. They are all venal and corrupt; and the iniquities which they themselves practise they but feebly condemn in others. Justice is often interrupted by the clashing authorities of the different courts; an evil which neither the sovereign nor his ministers are anxious to remedy, seeing that it adds both to their power and profit. A suit is very soon brought to a termination, and not at great cost; but considerable sums are often paid for a favourable decision. The most barbarous rules are still followed in the administration of the criminal law. In cases of murder the heir at law demands vengeance for blood; and when the guilt of the criminal is established, he is delivered into the hands of the injured person or his relations, to deal with him as they think fit. The revolting spectacle of private vengeance was witnessed by the English resident at Abushehr, as inflicted on the murderers by the relations of the deceased, who led their victims bound to the burial-ground, and there put them to death; the infant children of the person murdered being made to stab the murderers with knives, and thus to avenge their father's blood. The assassins of Aga Mahommed Khan, when they were executed, were stabbed by such of the younger children as could hold a dagger; and the successor of Nadir Shah sent one of his murderers to the females of his harem, who were delighted to welcome his executioners. The punishment of crimes in Persia is fixed by the written law, or, when the king interferes, by his arbitrary will. Fines, flogging, and the bastinado, are the common punishments of lesser offences. The disclosure of hidden treasures is enforced by tortures; and the inhuman punishment of putting out the eyes has long been practised in Persia, as in other countries of the East, on the relations of the reigning family who may aspire to the throne, or on the chiefs of tribes whom it is desirable to deprive of power, though not of life, and sometimes on the male inhabitants of a rebellious town. Criminals are put to death by strangling, decapitation, or stabbing; but in aggravated cases the most inventive cruelty is practised in devising modes of torture. In some cases, life is for a time preserved in protracted pain; in others persons are empaled, or their limbs torn asunder by the elastic bound of trees which have been bent for the purpose, or they are cast headlong from a high tower; and the history of Persia abounds with examples of tyrants glutting their vengeance on their victims by the most shameless insults and horrid injuries. In Persia women are seldom publicly executed, but they suffer dreadful violence in the recesses of domestic tyranny. When they are of high rank, the comprehensive injustice of the East often includes them in the punishment of their husbands or fathers; and they are given away as slaves to the lowest and most infamous classes of the community, such as mule-drivers. They are also sometimes tortured, in order to force from them a disclosure of wealth which they know to be concealed.

Revenue.

The collection of the revenue is intimately connected with the administration of justice, the same officer presiding over both; and this union is unfavourable to the inhabitants, as it enables the collector to prostitute the judicial power for the gratification of his avarice. Sir John Malcolm estimates, though not on any sure data, the revenue of Persia at three millions. According to Frazer, the amount varies with each successive sovereign, with the extent of his dominions, and with the fluctuations which have taken place from rebellions in the different provinces. The public income of Persia arises from the produce of crown or government lands, from a tax on land, varying, as is stated by Sir John Malcolm, from twenty to five per cent. according to the fertility of the land, and according to its vicinity to water, which is the great source of fertility in Persia. Frazer states that the land-tax amounts to from ten to five per cent. on the gross produce. Landed property in Persia may be comprised under the following heads: 1*st*, the crown-lands; 2*d*, those that are the property of individuals; 3*d*, those belonging to charitable or religious foundations; and, 4*th*, those granted by the king for military service. The uncultivated tracts, which form so large a portion of Persia, are not claimed as property; but every individual who constructs one of the subterraneous canals called *cannauts*, or who contrives to bring water to the surface, obtains a title to the land which he cultivates. The other titles are, inheritance, purchase, or a gift from the crown; and these rights are held sacred under all circumstances. There is, however, this peculiarity in the state of landed property in Persia, as in other eastern countries, that the ryot or cultivator shares with the proprietor in a common right to a certain portion of the soil, of which he cannot be deprived as long as he pays the customary rent. The proprietor has a title to one tenth of the produce, ascertained by measurement, either of the surface before sowing, or of the standing crop. When the proprietor obtains an artificial supply of water, he has, besides, a right to all that he can procure by its sale. In cases where the proprietor furnishes seed, labour, or cattle to the cultivator, he receives, in addition to his tenth share, a portion of the farmer's profits. The government-tax amounted at one time to one tenth of the produce, but with the increasing expenses of the state other irregular taxes were imposed, till they were at last converted into an additional tenth; the less fertile lands being, however, subjected to a smaller impost. But other irregular imposts still continued to be heaped upon the additional tenth, by the bad faith of the government, which imposts were altogether capricious and arbitrary, and now form one of the ryot's heaviest grievances. The other taxes are those on cattle, capitation taxes, transit and town duties on merchandize, and various other impositions which are quite uncertain and irregular. Lands held in fief, or in lieu of military or other service, pay no tax to government; the assignee being entitled to three tenths, which includes both the proprietor's rights and the government dues. When the assignment is given on the estate of another, it is merely the government-dues which are granted. Gardens near villages pay one fifth of their produce in kind, whilst melon-grounds, tobacco, cotton, and such like fields, pay in money according to a valuation of their produce. Horses, asses, cows, sheep, and goats, are all taxed, at the rate of one real, or 1s. 4d. for each horse, four fifths for asses and cows, one third for sheep and goats, and one sixth on the hire of bees. There is a capitation-tax, which sometimes presses heavily upon Armenians, Jews, and Guebres, the ancient fire-worshippers. The rate was in some cases four reals, or 5s. 4d., for a family, and sometimes eight reals. Shops and bazaars pay a duty of from two to twenty reals a year; and the tenant also pays in the proportion of from ten to fifty tomauns a year, the value of the tomaun being 11s. All merchandise is subject to a duty of five per cent. on entering the first Persian town, whether by land or sea, and to a variety of inland duties, which are levied at the different custom-houses without any rule or system, every governor endeavouring to extort all that he can. Smuggling is very commonly practised. No estimate can be formed of the *saaduraut*, or the irregular duties, which include every extraordinary expense of the government, the expenses of all travellers and strangers, those of all members of the royal family, or messengers on government business, the expense of transporting baggage, royal equipage, or presents, of repairing the roads and bridges, of furnishing troops for service, and the like; for all which it is understood, though the practice is often different, that the village or province shall obtain credit on the annual settlement of their accounts; so that these heavy exactions, resembling those of the king's purveyors in ancient Europe for the maintenance of his court and retinue when they were travelling, fall without redress on the poor ryots. The Persian king's order is, in like manner, grievously abused to the oppression and vexation of his subjects. Presents, fines, and confiscations, form a considerable item of Persian revenue. At stated times, such as the new year, the courtiers are expected to accompany their respects to the king with a large present of money, which amounts in some cases to 50,000, 60,000, and even 100,000 tomauns. Every one in any degree dependent upon the court endeavours to make up a purse on this occasion; and in lieu of money, goods, such as shawls, horses, jewels, and merchandise, are brought. The produce of this new-year impost is estimated at 1,200,000 tomauns. But there are various other lesser occasions for making presents, no suitor for favour or pardon being expected to approach the throne empty-handed; so that about 500,000 tomauns may be received in addition to the presents of the new year. The produce of the crown-lands Frazer estimates, though he admits, on uncertain data, at 989,000 tomauns. Every mode of tyranny and extortion is practised on the one hand by the collectors of the revenue, which is met by shifts and pretexts without number on the part of the tax-payer; "so that," says Frazer, "there is a continual struggle between the governor of a province and his myrmidons on the one side, and the villagers with their zabuts and ketkhodas (head officers) on the other; the former endeavouring to squeeze as much more as possible than their right from the latter, who strive, by every trick and invention, to avoid paying even that acknowledged right."[1]

The expenditure for which this revenue has to provide cannot be estimated from any authentic document. The chief expenses are the maintenance of the royal family, and the royal harem, which contains 300 wives, with a proportional number of slaves and servants, amounting to not less than about 1500 persons. The expense of the royal stud, including the baggage, camels, and mules, the retinue attending the royal march, the value of presents, namely, the khilauts or robes of honour, which are regularly given away, and which are seldom worth less than from 500 to 600 tomauns; the Cashmere shawls, swords, daggers highly ornamented, and horses with gold or silver harness; form a serious drain on the royal treasury; and to this may be added the maintenance of the household troops. All these expenses are heavy, and in general swallow up a large portion of the revenues, however ample. The superior officers of government are paid with the utmost parsimony, which proves in the end far more expensive than the most liberal salary, their scanty allowances being made up by peculation and extortion. The salary of a prime minister does not exceed a few hundred tomauns in the year, but it is made up to an indefinite amount by bribes, presents, fees, and speculations of various kinds. Sometimes an assignment on the revenue of a village is given in lieu of salary; the inhabitants being thus placed at the mercy of the assignee, who fleeces them without mercy, often to more than three times the regulated amount. All these unjust practices are well known to the king and his court, who wink at what they would find it impossible to prevent, and who also know that all the hoards of individuals are carefully watched by the spies and underlings of the court, so that these ill-gotten treasures may be made forthcoming at any time for the behoof of the monarch. The nobles, and especially the officers of government, are wretchedly poor, as well, indeed, as all the rest of the people; they are mostly all ruinously in debt. The mehmandar or officer of government, who escorted Frazer from Bushire to Shiraz, in describing his own situation, spoke openly of the "miserable system of extortion and parsimony practised by the king and rulers of the land;" and he was far from being the only one who uttered such sentiments, which, according to the traveller above mentioned, were in every mouth, and a common topic of conversation.

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[1] Narrative of a Journey into Khorassan, chap. x.

There is no regular body of trained soldiers in Persia, but merely irregular levies, fitted for the species of warfare in which they are generally engaged. Every province ought to maintain a certain number of men, armed and mounted, and ready to take the field. This is the national force of Persia; the militia collected from the wandering tribes, and from the inhabitants of cities and villages, who are liable to be called out on any emergency, and, when on service with the army, or in distant garrisons, receive pay from government. They provide their own clothing, which is the common dress of the country, and their arms, consisting of a matchlock, sabre, and dagger. The number of this registered militia is estimated at 150,000 men. But recently all military duties have been neglected, and it would now be scarcely possible to muster the smallest appearance of an army. The inhabitants of Fars obtained an abatement of revenue, on the ground of their obligation to maintain a force to watch the movements of the British in the gulf; but not a single soldier could ever be seen by the British embassy in passing through that province; and any military display that was made was evidently by men suddenly called together from their regular occupations. No attempt was ever made to maintain a regular army, excepting by Abbas Mirza, governor of Azerbijan, and heir apparent to the throne; and whilst these troops were commanded and disciplined by English officers, they had every appearance of an efficient force, amounting to 20,000 men. But after the conclusion of peace with Russia, they were, from parsimony or improvidence, disbanded; it being considered as useless to give regular pay where no service was required. On the commencement of the Turkish war, the English officers, who could no longer be permitted to serve, were almost all dismissed; and a few sergeants only remain, who command and maintain the horse-artillery in a tolerably efficient state; but this corps, with seven or eight hundred Russian deserters, is the only serviceable part of the establishment. The prince has, besides these corps, wall-pieces, mounted on camels, which could only be efficient against Asiatic troops. His arsenal is, however, miserably furnished; and, unlike the arsenals of Europe, which contain such vast stores of ammunition, it is on a scale more suited to the shooting-closet of a private gentleman, than a magazine of state. When the army took the field against the Russians, only twenty-five rounds of ammunition were provided for each gun, and scarcely any supply was left behind, whilst the manufacture was proceeding on a scale the most pitiful. The levies furnished by the chiefs of tribes at the call of their sovereign form the most efficient portion of the militia, consisting entirely of cavalry, which, though somewhat degenerated, are still hardy and active, having preserved the habits and mode of fighting of their fathers. Their horses are active and strong, and in all respects suited to predatory warfare, to which indeed they are inclined by the prospect of plunder, the chief motive of their services; for if they are not engaged in active hostilities, they always return home during the winter.[1] The Persians assert that the king can command the services of 80,000 of these irregular troops; an assertion which is scarcely borne out by facts. Some provinces famed for their irregular troops serve as nurseries of the army. The land-tax of Mazanderan is chiefly paid in military service, and this province, including Astrabad, maintains nominally 12,000 foot and 4000 horsemen, ready at a call. But the fact is, that these troops are greatly dispersed amongst their own villages, and many of them have not a horse to show. The only permanently-embodied corps is the body-guard of the king, or the *gholauns*; but they have no regular organization, any more than the others, nor do they assemble and parade together. Their number amounts to from three to four thousand men; and they are chiefly distributed near the residence of his majesty in town, and attend him in camp, a certain number being always on duty. They are all mounted, their horses being found by government, and they are armed, as usual, with a matchlock or sword. Their pay varies from twenty to thirty tomauns in the year; though those of long standing, and of tried valour in the service, receive much more. These are frequently employed in affairs of great importance; often in the collection of the revenue, when they neglect no opportunity of extorting large sums. They consider themselves as gentlemen, though in the rank of soldiers. They are, some of them, the younger sons of nobility; and are for the most part bold and insolent debauchees, great swaggerers, with but little courage, tyrannizing over the weak, but respectful and fawning to those in power. Their name is a terror to the country, and their arrival in any quarter is deprecated as a serious misfortune, the people in some instances flying from the village at their approach. Frazer considered the unwarlike character of the Persian monarch as a great discouragement to the military service. He was cowardly, and remarkably avaricious; parsimonious in rewarding service, and jealous of any of his subjects acquiring military renown; so that a chief, when they were proposing an expedition against the Turcomans, declared his own feelings in very plain terms: "To what end," said he, "should I destroy these people? What thanks should I receive from Futteh Allee Shah? Perhaps to have my eyes put out."

Persia, from this view of her internal sources, must rank very low in the scale of nations, and would be quite unable to withstand any European power. During the war which so long raged between Great Britain and France, her alliance was eagerly courted by both these powers; by the former, in order to baffle the supposed schemes of Napoleon for the invasion of India, although it is extremely doubtful if any such were seriously entertained. France was equally eager for the friendship of this weak state. Great Britain lavished her gold on the Persian king, for which he gave his empty promises of friendship; and when France entered the lists with Britain for his coveted alliance, the king made the most of both; nor, as Frazer justly observes, was it his part to tell how valueless was the prize for which they each offered so high. The British statesmen, perpetually haunted with the terror of Bonaparte, were in dread lest a French and Russian army should make its way through Persia to India. But neither the cajolery of Great Britain, nor her bribes, would have enabled Persia to oppose so powerful an invasion of her territories, if it had been attempted. Her whole power would have been exerted in the defence of her dominions, even if Britain had not interfered; more she could not do though the whole wealth of the country had been poured forth before her king and his nobles. Most uselessly, therefore, on this, as on numberless other occasions, were the treasures of Britain squandered away to bribe this barbarous power to pursue a course prescribed to her, and which she would of herself inevitably have followed in her own defence; whilst the character of the country was lowered, by the humble, and even fawning, tone of the British in their official communications. Persian arrogance has been thus fostered; and the Shah has been encouraged to despise and deprecate the power and alliance of Britain, notwithstanding her profuse liberality.

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[1] Sir John Malcolm's History of Persia, vol. ii. chap. xxiii.

Religion.

The ancient idolatrous religion of Persia was supplanted by that of Mahommed, which at an early period was propagated in Persia by the victorious Moslemins; and it has ever since continued the popular superstition of the country. But the Persians are of the Sheah sect, who consider Ali, the uncle and father-in-law of Mahommed, as his lawful successor in the caliphate, to which he was appointed by the Prophet; and Abubekr, Omar, and Othman, his actual successors, and reverenced as the caliphs by the Soonies, as nothing better than usurpers. It was this disputed succession which gave rise to these two hostile sects of Mahommedans. The doctrines of the former, namely, the Sheahs, have been for more than three centuries warmly espoused by the Persians, who vowed eternal hatred and war against all who profess the Soonie creed. The religion of Mahommed, amongst its other evils, is hostile to all improvement. It enjoins the destruction of infidels as an act of piety; intolerance thus becomes a duty; and hence the blind zeal and persecuting spirit which prevails in all Mahommedan states, and which breaks out into reproach, outrage, and often into extreme violence, against their Christian visitors. All knowledge is, according to this system, rejected, beyond what is found in the Koran; and the debasing influence of polygamy on the morals and manners of both sexes is calculated completely to poison all the remaining sources of social happiness. The baneful consequences of this superstition have been as deeply felt in Persia as in any of the surrounding states. The Persians have been thought by travellers to be less bigoted than their Turkish or Arabian neighbours. But though, from their lighter dispositions, they may not be so austerely rigorous in their religious observances, and may even converse with more freedom on religious subjects, from their intercourse with European Christians, who cannot be used with the same outrage as their own countrymen, yet, according to the testimony of Frazer, they are even more deeply prejudiced than either the Arabs or the Turks, who will not scruple, if they invite a Christian to their house, to eat with him from the same dish; whilst a Persian will provide a separate tray for him, and avoid, as much as he can, all contact. Europeans attached to the suites of ambassadors are admitted into the public baths; but a European travelling without a mehmandar or a government functionary would not be allowed any such privilege; and though European gentlemen, for a large bribe, are admitted in disguise, or in secret, into the mosques or holy places of pilgrimage, a poor Armenian or a Jew would as surely be put to death if found within the sepulchre of Imaun Reza or Fatima, or the great mosque at Shiraz, as within the mosques of Constantinople or Damascus. The fanatical influence of the Mahommedan religion has of late years, however, been modified in Persia, by the progress of a free-thinking and irreligious spirit, chiefly amongst the nobility, the merchants, and those who have resided much in foreign countries, and even amongst the priesthood, who frequently and openly, before their particular friends, deride the superstitious observances of the Mahommedan creed. The zeal of the early Mahommedans has also been cooled by many causes. The work of conquest, and the extinction or conversion of infidel nations by the sword, is at an end. The enthusiasm of the modern followers of the Prophet is no longer influenced by the practice of persecution; and the whole system has declined into a set of useless forms and ceremonies, which, mingling with all the common affairs of life, have degenerated into a customary routine, without any appearance of reverence, and being in reality a mere mockery of religion. "The name of God," says Frazer, "in various forms, is called upon on the most trivial as well as the most important occasions. However men may be occupied when the set hour of prayer arrives, those who choose to observe it merely turn aside from the rest, still laughing, perhaps, at the last ribald jest, and commence their invocation of God. During the intervals they continue their conversation, scold or give orders to their servants, comb their beards, and adjust their persons, frequently interrupting their expressions of praise or of devotion, to give vent to the most trifling, or perhaps the most obscene remarks."[1] The observance of these empty forms is nowise connected with morality, except to degrade it; the most zealous Mahommedans, even those who have made the pilgrimage to Mecca, being frequently noted for the impurity of their lives. From this and other causes, the Mahommedan religion, which once kindled so vast a commotion in the world, is now on the decline; and the followers of the Christian faith have made such progress in all useful knowledge, that Mahommedans are fain to become the imitators of their fashions, as, by a gradual transition, they may also yet be of their purer faith.

In a state of society such as that which prevails in Persia, we can scarcely look for any great progress in literature, science, or the arts. With the Mahommedan religion was introduced all the Arabian learning of the seventh century. But the Persians have not improved this original stock; on the contrary, it has gone to waste in their hands; the light of science is nearly extinct, and their literature consists chiefly in their poetry and tales. They delight in tales, fables, and apophthegms, which Sir John Malcolm considers as the consequence of their despotic government, where knowledge must be veiled in order to be useful, as the direct truth would wound a despot's ear. It is in poetry that they are said chiefly to delight and to excel; though the hyperbolical style and the wild tales of the East would scarcely suit the fastidious taste of European critics. The merits of Persian poetry have been very differently estimated. Sir John Malcolm, admitting its extravagance and hyperbole, still praises its tenderness and beauty; and many passages are said to breathe all the sweetness of pastoral poetry. Ferdousi is one of their greatest epic poets, whose poem (the *Shah-nameh*) is historical, in which, according to Sir John Malcolm, "the most fastidious reader will meet with numerous passages of exquisite beauty. The narrative," he adds, "of this great work is generally very perspicuous; and some of the finest scenes in it are described with simplicity and elegance of diction." In the opinion of Persians, this poet excels in his descriptions of the combats and battles of his heroes; but to those whose taste is offended with hyperbole, the tender parts of his work will have most beauty, as they are freest from this characteristic defect of eastern writers. Nizamee, who celebrates the exploits of Alexander the Great, is considered as ranking next to Ferdousi; and the subject affords ample scope to his genius and his powerful imagination. Amongst the didactic poets Sir John Malcolm assigns the next rank to Sadi, who is a moralist as well as a poet, his works abounding in the most useful lessons of prudence and morality, and exhibiting a rare union of fancy, learning, urbanity, and virtue. The Musnavel of Jellal-u-Deen, the poems of Jami, and the odes of Hafiz, are amongst the most popular effusions of the Persian muse; but the names of Rudiki, Anveri, and several others, are nearly of equal rank; and some modern writers also have attained to great eminence. "Many of these poems," says Sir John Malcolm, in his excellent History of Persia, "are remarkable for harmony of numbers and luxuriance of imagination, but they all abound with the most extravagant and hyperbolical passages; and the enraptured dreams of their visionary authors can only be esteemed beauties by men whose imaginations keep pace with that of the poet, whom they deem inspired, and whose most obscene lay is often considered by their enthusiastic admirers as the gleaming of a sublime knowledge, which is far beyond the comprehension of the profane and unenlightened. Many discussions have arisen regarding the real and mystical meaning of the writers of this class, and particularly of Hafiz, whose odes are chanted as songs, to excite the young and dissipated to pleasure, and recited as hymns, to remind the old and devout of the rapture of divine love." The Persian poets excel in songs and odes, which are chiefly composed on local subjects, and are tender and passionate. Satirical effusions are not so common; though the verses of Ferdousi on Mahmood of Ghizni are remarkable for the bitter feelings which they express. There is a satirical poem, by an unknown author, on the passion of avarice, which is extremely humorous and satirical. The Persians are enthusiastic in their taste for poetry; and the meanest artisans can read or repeat the finest passages of their most admired writers. Sir John Malcolm mentions that his servants were familiar with Persian poetry; and when at Ispahan, he was surprised to hear a common tailor, who was repairing one of his tents, entertaining his companions with some of the finest mystical odes of the poet Hafiz. Even the rude and unlettered soldier will leave his tent to listen to songs of love or to a tale of war. The art of printing is unknown in Persia; and beautiful writing, which is carefully taught in the schools, is considered as a high accomplishment; those who excel in it ranking with the literary class. They are employed in copying the works of authors; and a few lines written by a celebrated penman are often sold for a considerable sum. By the invention of printing a great moral revolution has been brought about in the state of society; and a want of inclination to profit by this great improvement indicates extreme apathy and ignorance on the part of any nation. Yet almost all the tradesmen and many of the mechanics in Persia have received some education. Schools are established in every town and city, at which the poorest children are instructed, at fees sufficiently reasonable, in the rudiments of the Persian and Arabic languages. The pupil, after he has learned the alphabet, reads, as a religious duty, the Koran in Arabic, next some fables in the Persian language, and, lastly, he is taught to write a legible hand, which completes his education. Unless amongst those who follow a studious life, and thus put in practice what they have learned, these lessons are in many cases forgotten. Yet this course of study, superficial as it appears, improves the habits, and introduces a refinement of manners amongst the scholars, which is unknown to their ruder countrymen. No proper encouragement, however, is given to schools; nor can it be expected that a grasping, despotic, and rapacious government, like that of Persia, should be any way anxious for the education of its subjects. The literary men are numerous. They pursue their studies till they are entitled to the name of Moollah, and to all the honours of a Persian college, though they are not classed with the priesthood. They follow various occupations. To the studious and literary classes a very high rank is assigned. An eminent historian, astronomer, or poet, is highly honoured, and has a place of distinction assigned him in every company which he honours with his presence; and this as much for his social qualities as for his supposed talents as an author. The conversation of these persons, replete with anecdotes and information, amuses and instructs; and even the pretenders of this class, who are numerous, possess agreeable manners and a ready wit. Living by their wits, they are generally noted flatterers, dwelling especially on the wonderful deeds and character of the king or his principal nobles, for which they are well paid. Others write panegyrics on all who pay them for it, either in money or in hospitality. They also make epigrams to amuse their patrons, or recite the finest passages of the national poetry. But the great majority are poor, seeing that their numbers have outgrown their employment. Every person with a moderate education may assume the name of a poet, and the merest rhymer receives some additional respect upon this account. A swarm of students is thus produced, who pass their useless lives in indolence and poverty. Ispahan in particular abounds with these literary mendicants; and from its colleges, and those of Shiraz, issue a crowd of vagrant poets, who lie in wait for men of rank and wealth, or for any stranger from whom they expect a reward. Sir John Malcolm, in his first visit to Persia in 1800, was addressed by one of these poets; and though he was repeatedly told that the stranger could neither comprehend his lines nor relish such compositions, he persevered in his purpose, telling some appropriate story, until he extorted his due meed, not of praise, but of money.

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[1] Narrative of a Journey into Khorassan, chap. ix.

In music and painting the Persians have made no progress. They consider music as a science, but they have nevertheless made no further advances in it than the Indians, to whom they are supposed to owe all the knowledge which they possess. They have a gamut and notes, and a melody that is adapted to various strains; and they sing to the accompaniment of warlike instruments, of which they have a number. Their strains are often pleasing, but they are always monotonous. They are equally backward in the art of painting, in which they have advanced but little within the last three centuries. They use the most brilliant colours, and in portrait-painting they usually succeed in taking likenesses; and in some of their lesser drawings, which are highly glazed, and painted on wood, they also display industry and taste. But they are entirely unacquainted with the rules of perspective or of just proportions. The despotic and unsettled government arrests all improvement; and in the fine arts the existing race have not advanced one step beyond their forefathers, as appears from the figures in the palaces at Ispahan, executed in the reign of Shah Abbas, and equal to any of their modern productions.

Mathematics, astronomy, and geography.

In science the Persians have advanced no farther than in the arts. Their knowledge of mathematics or astronomy is very limited; and the latter science is chiefly studied for the sake of judicial astrology, in which the whole nation, from the king to the peasant, evince the greatest faith. Their notions of the forms and motions of the heavenly bodies, and the shape and surface of the earth, are borrowed from Ptolemy; and though some efforts have been made

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to instruct them in the Copernican system and Newton's demonstrations, prejudices are too firmly rooted to be dispelled, except by time. Of geography they do not understand the first principles; for, independently of their error regarding the figure of the earth, they know little of its surface, even of that which lies within their view; nor could their knowledge of surveying enable them to lay down any portion of it with exactness. There cannot be a stronger proof of the ignorance which prevails than the eagerness with which all classes seek the aid of astrology. Any one who can take an altitude with an astrolabe, or knows the names of the planets, with a few technical phrases, and understands the astrological almanacs, considers himself as quite adequate to offer his services to all who consult him; and nothing of consequence is transacted, especially by the great, without consulting the stars. A new dress must be put on, or a journey must be commenced, at the lucky or unlucky moment. The prime minister of Persia seeing Sir John Malcolm smile at the idea of his seeking the propitious moment for putting on a new dress, observed, "Do not think, Captain Malcolm, I am such a fool as to put faith in all this nonsense; but I must not make my family unhappy by refusing to comply with forms which some of them deem of consequence." Some years ago a Persian ambassador was about to proceed to India, when he was informed by his astrologer of a most fortunate conjunction of stars, not likely to occur again for some months. He accordingly set out, though the ship was not ready to sail; and because it was discovered by the astrologer that he could not go out of his door, on account of an unfavourable constellation exactly opposite, he broke through the wall of his house, and four or five other walls, before he and his men could reach the street. Many of the astrologers who practise this art are with reason thought to be more knaves than fools, and flatterers of those who consult them, in order to fleece them of their money.

As the science of astronomy is thus rendered subservient to astrology, so chemistry is followed for the sake of alchemy, a favourite pursuit of the learned, whose avarice is stimulated by the hope of discovering the philosopher's stone; that absurd chimera of a barbarous age, long ago exploded amongst the sciences of Europe. The alchemists make their experiments in the profoundest secrecy, that they may themselves engross the whole benefits of the wonderful discovery which they expect to make; and whether they may be themselves deceived, certain it is they deceive others, and practise the most serious frauds on the credulous and the wealthy. Of medicine and surgery the Persians are thoroughly ignorant, and, when they are ill, become the prey of quacks, who rob them of their money, and often of their health. They are entirely ignorant of anatomy and the circulation of the blood. They have an arbitrary theory, by which they classify all diseases under four heads, viz. hot, cold, moist, or dry; and the great principle on which they proceed is, that the remedy must be of an opposite quality to the disease; dry remedies being applied to an illness occasioned by moisture, and cooling medicines to hot diseases. To this practice they are so bigoted, that, with all their respect for European physicians, they dislike any prescriptions that contradict this paradox. Inoculation for the small-pox, though it is known, is seldom practised, though whole towns are often threatened with depopulation by the ravages of that dreadful disease. Mr Jukes, who accompanied Mr Frazer into Persia, was remarkably anxious to introduce the practice of vaccination: for several years his efforts were unremitted; but they were defeated, fully as much from the cruel indifference of the government to the good of their subjects, as from their prejudices. This great and important discovery appeared to give the most lively satisfaction to the great men of the country; but that interest in the happiness of the people, and those feelings of humanity, which are seen in Europe, are entirely wanting in Persia; and hence all attempts to introduce vaccination amongst the people were finally abandoned. The practice of physic in Persia is mere quackery, for which all the knowledge necessary is that of the qualities and effects of a few simples; and hence a grave air, and a few lucky cures, often brought about by the temperate habits of the patient, complete the fame of a physician. The gains of the physician are, however, trifling. The priests and astrologers succeed better; their art is more suited to the taste of the inhabitants; and it is only in cities and towns that there are regular physicians. Those who dwell in tents are generally attended by an old man or woman, and rely more on superstitious charms than on medical remedies. One of these charms consists in laying a few pieces of bread covered with oil upon a rock, as an offering to a saint. There are many quacks in Persia, as in other countries, who pretend to cure all diseases, and who boast a hereditary right to certain nostrums. The chiefs of a mountain tribe pretend to cure the ague by tying the patient up by the heels, and scolding and beating him severely, to prevent the access of the cold fit.

Mann and toms

The Persians are remarkably ceremonious in their intercourse. They receive the visit of a superior by rising hastily and meeting him at the door of the apartment; of an equal, by rising and standing erect; of an inferior, by only making the motion of rising. The apartments are not so luxuriously furnished as in Turkey. The sofas and easy pillows of the latter country are not known in Persia, where the seat is on a carpet or mat, without any soft support on either side, or any thing except the hands, or the accidental support of a wall, to relieve the galling posture of the legs. The fashion in presence of a superior is to sit upon your heels, as they are tucked up under your hams, after the manner of a camel. The misery of this posture in its politest form can scarcely be described, according to Morier, who thought he had attained to great perfection in the Persian fashions when he could sit cross-legged like a tailor; and Sir R. K. Porter mentions, that after a Persian entertainment at which he was present, he was so tired with the awkwardness of the posture, that he could scarcely rise when the meal was finished. The length of time during which a Persian sits untired upon his heels is to an Englishman quite extraordinary. He will remain half a day, and sometimes he will even sleep, in this posture. They never think of changing their positions; and are as much surprised by the locomotive dispositions of the Europeans as we are by their habits of rest. They impute their walking to and fro, their sitting down, getting up, and moving in every direction, to the influence of some evil spirit; and sometimes they think it is the European mode of saying prayers. Morier gives a curious account of a visit of ceremony to the governor of Bushire, and also of a dinner at which he was entertained. They made their visit on horseback, according to the custom of the country, though his tent was not a stone's throw from theirs. They were met by one of the officers, with an escort of ten men, who made their obeisance; and when they arrived at the door of the khan, where they were most graciously received, having pulled off their boots and shoes, a necessary part of the ceremonial, they were finally accommodated with chairs prepared for them. The tent was extremely neat; and in the interior there was a clean little recess, closely covered with carpets, and lined with the finest chintz, adorned with a broad fringe. They were then entertained with *kaleoons* or water-pipes, and with coffee and sherbets; and the whole entertainment concluded with a course of sweetmeats, consisting of almonds, pistachio-nuts, with a paste of sugar, and other sweetmeats, of which the Persians are immoderately fond. The fastidiousness of the English visitors was, however, sorely tried by the ill-timed complaisance of two lusty attendants, who broke the sweetmeats with their fingers, and blew off the dust of the fragments with their mouths. At dinner they sat on the ground in the position already mentioned, which was rendered more difficult than can be conceived, by the inflexibility of their knees, contracted from long habit; and the khan, in pity to their evident distress, begged them to extend their legs at full length, which they, however, declined, in compliance with the Persian fashion. After being treated to pipes and coffee, dinner was called for. On the ground was spread a fine chintz cloth, which completely covered their legs, and had been so long unchanged, that it was dirty from the fragments of former meals, and emitted no very savory smell. But the Persians never change it, from an idea that it brings ill luck. Sherbets were first served up upon fine china bowls to each guest, two made of sweet liquors, and another of an exquisite species of lemonade. There were, besides fruits ready cut, plates with sweetmeats and confectionery, and smaller cups of sweet sherbet. The pillaus succeeded, one of plane rice, another made of mutton with raisins and almonds, and a third of fowl with rich spices and plums; also various dishes with rich sauces, and over each a tincture of sweet sauce, which is a great article in Persian cookery. The Persians eat comfortably in their fashion, advancing their chins close to the dishes, and commodiously scooping the rice or other victuals into their mouths with three fingers and the thumb of their right hand. But when the English guests attempted to approach the dish, they were impeded by their tight-kneed breeches, and all the ligaments and buttons of their dress; and in the course of their eating, fragments of meat and rice fell through their fingers all around. The dinner was carried off in the same state in which it was brought; the servant who officiated dropping gracefully on one knee as he carried away the trays, and passed them over his head with both his hands to another lacquey, who was ready behind him to carry them off.

It is a singular trait of Asiatic manners that so great a proportion of the people still retain the vagrant habits of the pastoral life. For this purpose the wide wastes of Khorassan, varied with spots of fertility, are well adapted; and the pastoral tribes are accordingly found chiefly to border on this district, which has long been the debateable ground between several great monarchies, where their rival chiefs contended for victory in fierce and bloody wars; and on these occasions the wandering tribes are enlisted on one side or the other. Thus they are inured to blood and to pillage, and contract habits which have been strengthened by time, and have at last become interwoven with their whole pursuits and character. They often attack surrounding states, carry off the people, and sell them for slaves; and most of the wandering tribes of Turcomans being Soonies, who have sworn eternal hatred to the Persians, who are Sheahs, thus add religious hatred to all their other incentives to murder and pillage; so that their character is described as ferocious and blood-thirsty in the extreme. To the north of Khorassan there are various tribes of Turcomans, who, occupying the country behind the Elburz and the steppe of Kaurezm, pour from their deserts upon the surrounding and cultivated districts, plundering villages and caravans, with every circumstance of atrocious outrage. The old, the feeble, and the helpless, are murdered on the spot; those who are fit for labour are carried into slavery; and whole districts of country are left desolate. From the east other tribes equally barbarous make inroads into Persia, and carry away their captives to the slave-markets of Khyvah and Buckharia; and on the south and east are found the wild Ballooches, who formerly plundered and murdered, but now, preferring their avarice to their cruelty, carry their prisoners to the slave-merchants who frequent the great northern markets. The Afghan, also, though not naturally cruel, "assumes," says Frazer, "in this ominous neighbourhood a fierce character, and adds to robbery and plunder the crime of murder." By these dreadful inroads a considerable portion of the country to the north and east is laid waste; the terror of these tribes is spread far and wide; and their depredations have become more formidable in proportion to the corruption and increasing weakness of the Persian monarchy. These tribes vary considerably in their physiognomy. The Tuckehs, who occupy the country behind the Elburz Mountains, bordering on the Caspian Sea, are tall, stout, and well made, and have all the Tartar features, namely, the scanty beard, the small eye drawn up at the corners, the high cheek-bones, and the small flat nose. Some, on the other hand, have handsome features, rather resembling those of the Asiatics than of the Europeans. The arms used by these tribes are chiefly the sword and the spear. They are dexterous in the use of the sword, which is curved in the Persian fashion, and very sharp. Several of the tribes use bows and arrows. They have very few fire-arms; only such as they have taken from travellers whom they have plundered.

Antiquities.

Persia, the seat of learning, of wealth, and of improvement, whilst the greater part of the world had scarcely emerged from barbarism, might naturally be expected to abound in the precious relics of ancient art; and although many such memorials have perished amidst the ruthless devastations of war, to which this and other Asiatic countries have been exposed, yet numerous monuments of taste still remain. Of these, the ruins of Persepolis belong to the earliest era of Persian history. It was in this city, which they took a delight in improving and embellishing, as the great metropolis of the East, that Cyrus and his immediate successors resided. It has for centuries presented only a scene of decay and ruin. The most remarkable remains in Persepolis, or, as it is called by the natives, Tackt-i-Jemsheed (the throne of Jemsheed), are the Chehelminar or the forty columns, which are situated at a small distance to the north of Shiraz. Sir R. K. Porter recognised in these ruins, *en masse* as well as in detail, a strong resemblance to the architectural taste of Egypt; and he conjectures that some of the architectural ornaments may have been partly brought from that country by the Persian monarchs, as trophies of their victories. These magnificent remains appear to be part of the great castellated palace of Darius, which was set on fire by Alexander whilst he was under the influence of intemperance. They are placed as if in an amphitheatre, on a fine plain, enclosed by semicircular mountains. The terrace on which the ruins of this immense royal citadel or palace is placed, is of a very irregular shape, and it faces the four cardinal points. The extent of the southern face, according to the measurement of Sir R. K. Porter, is 802 feet; of the northern 926, and of the western 1425. "The strength and beauty of its construction," says the same traveller, "cannot be exceeded. The steep faces of the rocky terrace are," he continues, "formed of dark-gray marble, cut into gigantic square blocks exquisitely polished, and, without the aid of mortar, fitted to each other with such closeness and precision, that when first completed the perfected platform must have appeared as part of the solid mountain itself."[1] The level on which the buildings had been erected has become exceedingly uneven, from the accumulation of fallen ruins; and the height of the wall appears to have varied from twenty-five to fifty feet, according to the inequalities of the ground. The exterior wall is built of black stones much harder than marble, finely polished, and of such a prodigious size, that it is difficult to conceive how the workmen, without the aid of machinery, were able to move them. The only access to the summit of the platform is by a double flight of stairs of a very gentle ascent, on its western side. There are fifty-five steps, each step being three and a half inches in height, formed of blocks of marble so large that each of them is cut into ten or fourteen steps. The first flight of steps leads to an irregular landing-place of thirty-seven feet by forty-four, from which springs a second double flight of forty-eight steps, which terminate on the ground level of the platform in a second landing-place, occupying sixty-four feet. "The beauty and ease of the ascent," says Sir R. K. Porter, "will be readily understood when I mention, that I invariably rode my horse up and down them, during my visits to their interesting summit." On reaching the platform, the first objects that arrest the attention of the traveller are the lofty walls of an enormous portal, the interior faces of which are sculptured into the colossal forms of two immense quadrupeds, resembling bulls, which are elevated on a pedestal five feet in height. The heads of the animals are entirely mutilated, so that Frazer says it is impossible to determine what species they were intended to represent. Round their necks collars of roses are executed with critical nicety; and over the chest, back, and ribs, short curling hair, cut with that peculiar correctness and delicacy of chiselling which Sir R. K. Porter states to be a distinguishing characteristic of the ancient Persian sculpture. The wall that forms one side of this magnificent portal is five feet in breadth, twenty-one feet in length, and thirty feet in height. The one wall is distant from the other about twelve feet, and the space between is flagged with beautifully-polished slabs from the neighbouring rock.

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[1] Travels in Persia, Georgia, &c. vol. i. p. 583.

Eastward, at the distance of twenty-four feet in a direct line from the portal, once stood four magnificent columns, of which only two now remain. Their capitals are singularly beautiful. At the distance of twenty-four feet is a second portal, exactly resembling the former, only that it is eighteen feet instead of twenty-one in length. Its inner sides are adorned with similar sculptures. But the animals here represented are of a gigantic size, and of a monstrous formation; the body and legs of a bull, with similar trappings to those already described, and enormous wings, the feathers of which are exquisitely cut. The heads of the animals, though greatly defaced, show the faces of men; the countenance has a cast of deep gravity; and a long and carefully curled beard adds to the general majesty. The head is adorned with a diadem, on both sides of which horns are represented winding from the brow upwards towards the front of the crown; the whole being surmounted by a sort of coronet, formed of a range of leaves like the lotus, and bound with a fillet beautifully carved in roses. This symbolical representation has long been a subject of speculation amongst antiquaries, and its meaning still remains a mystery, notwithstanding the many ingenious conjectures to which it has given rise.

Between the right of this portal and the magnificent terrace that supports the range of columns from which it takes its name, there is an area of 162 feet, in which is a cistern hewn out of the solid rock, in dimensions eighteen feet by sixteen. The approach to the terrace is superb, consisting of a double staircase, covered with the most beautiful decorations, and projecting considerably before the northern face of the terrace, which is 212 feet in length. At each extremity, east and west, rises another range of steps; and about the middle, projecting from it eighteen feet, appear two smaller flights, rising from the same points. The extent of the whole range, including a landing-place of twenty feet, amounts to eighty-six feet. The ascent is extremely gradual, each flight consisting of some thirty low steps, four inches in height, fourteen in breadth, and sixteen in length. The whole front is covered with sculptures so thickly that the eye is bewildered amid the various groups. They consist chiefly of figures and emblematical devices. The figures seem generally to be habited like royal guards or other attendants, clothed in long robes, with fluted flat-topped caps, carrying shields on their left arms, and wearing a sort of buskins, between the sole of which and the foot a small substance is introduced, to raise the height of the wearer. Others appear as if they were taking their part in solemn processions, bearing votive offerings, and leading animals of different sorts. Chariots are also seen drawn by different animals. These sculptures are executed with a nicety of detail which gives them a historical interest, as they mark with accuracy the costume of the time and the people, and the form and variety of the armour used at different periods. On these sculptures is also represented a fight between a lion and a bull or unicorn; Sir R. K. Porter greatly commends the fire, beauty, and truth, as well as the natural proportions, with which these figures are drawn. A particular account of the other sculptures will be found in the work of the above-mentioned traveller; and his descriptions are accompanied by drawings, which are extremely curious and interesting.

But the most splendid division of the ruins is the magnificent colonnade, which occupies the terrace, and which, having survived the devastations of war and the wreck of empires, remains on the desolate plain a most impressive image of departed grandeur. The terrace upon which these pillars stand stretches north and south 350 feet, and from east to west 380 feet; the greater part of the intervening space being covered with broken capitals, shafts of pillars, and numerous fragments exquisitely sculptured. There were formerly four divisions of columns, namely, a central group of thirty-six pillars, with two rows of six each on either side, as well as in front, in all seventy-two columns. Of the division in advance only one is now standing. About thirty-eight feet from the western edge of the terrace appears the second double range of columns, of which only five rows remain. The distance is 268 feet to the corresponding eastern rows, of which only four now remain. At a distance of sixty feet from the eastern and western colonnades stood the central range of columns, to the number of thirty-six; but of these no more than five remain entire. The three exterior double rows of columns are of uniform architecture, and described by Sir R. K. Porter as being perfectly beautiful. "I gazed on them," says he, "with wonder and delight. Besides the admiration which the general elegance of their form and the exquisite workmanship of their parts excited, I never was made so sensible of the impression of perfect symmetry, comprising that of perfect beauty also. The total height of each column is sixty feet, the circumference of the shaft sixteen feet, and its length from the capital to the top forty-four feet. The shaft is finely fluted in fifty-two divisions: at its lower extremity begins a cincture and a torus; the former two inches, the latter one foot, in depth. From thence devolves a pedestal, in form of the cup and leaves of a pendant lotus. It rests upon a plinth of eight inches, and measures in circumference twenty-four feet six inches; the whole, from the cincture to the plinth, comprising a height of five feet ten inches. The capitals which remain, though much injured, suffice to show that they were also surmounted with a double demi-bull. The heads of the bull forming the capitals take the directions of the faces of the respective fronts of the terrace; and I think there can be no doubt that the wide hollow between the necks received a beam, meant to support and connect an entablature, over which has been placed the roof." The dimensions of the central pillars are the same as those of the others, only that they are fifty-five feet in height, whilst the others are sixty feet. "Their shafts," says Sir R. K. Porter, "which are fluted like the others, are about thirty-five feet in length; but the capitals which surmount them are of quite a different character, being of the same description with that I noticed in the great portal where the crowned and winged bull is so conspicuous an object. The two lower divisions of the capital (it being of a triad form) are evidently constructed of the hollowed lotus. The upper compartment has only two volutes. The middle compartment, which is one division of lotus, appears to have had some extraneous body introduced into the opening between it and the lower compartment of the flower; and the angular and unfinished state of that side of the capital seems to testify the same. Here then the connecting line must have been whence the roof could spring."

The nearest building to the palace of the forty pillars occupies a space of a hundred and seventy feet by ninety-five, and it is approached by a double flight of stairs, which are almost in complete ruin; but from the fragments it appears to have been adorned with sculptures, resembling the royal guards and other figures. The side to the east is so choked up with ruins that no corresponding trace of stairs can be found. To the south the whole face of the terrace which supports this building is occupied with another superb flight of steps, which terminates in a landing-place forty-eight feet by ten. Its front is divided by a tablet bearing an arrow-headed inscription, on each side of which are seen spearmen of a gigantic stature. There appear to have been also other apartments with lofty entrances, composed of four solid upright blocks of marble of a colour nearly black, within the portals of which are bas-relief figures of two guards sculptured on the sides of the walls, besides various other figures, one of a monarch clad in royal robes; whilst in other parts there are representations of single combats between a man and a lion, a griffin, or some other imaginary creature. In another division of the same building may be seen a variety of inscriptions, cuneiform, Cuphic, Arabic, and Persian. Still farther to the southward appear other elevations or terraces, covered with vast masses of ruin, under which scarcely any traces of the original structure can be discovered; but here may be seen the remains of colonnades of elaborate sculpture. From the extremity of the eastern colonnade on the terrace of Chehel Minar is an expanse of 315 feet, the plain of which is interrupted by an immense pile of ruins, which has the appearance of having been heaped up for centuries, and which Sir R. K. Porter conjectures to cover a division of the palace answerable to that immediately to the south, and containing, as he supposes, the banqueting chambers and other apartments; and this conjecture he supports by many special reasons and learned authorities. South of this is another terrace, on which he supposes that there stood those portions of the palace in which the monarch resided. Here are the bases and plinths of pillars, and fragments of beautiful sculpture, scattered about. The ponderous door-ways and huge marble frames are yet in their places; they are of the finest workmanship, and are adorned with sculptures and figures such as those which have been already noticed, and of which our limits do not admit of a more detailed description. A considerable way north from the columns stands a structure which is next in extent to the Chehel Minar, or the palace of the forty pillars. It is a perfect square of 210 feet on each side, and is entered by two door-ways on each side, and by a grand portal thirteen feet in width, whilst the others are only seven. These are all richly adorned with sculptures, representing scenes of state or of royal parade, or emblematical figures of lions and imaginary animals.

Among other remarkable antiquities of Persia, the tombs, supposed to be those of her ancient kings, namely, Cyrus and his posterity, have attracted the particular attention of travellers. These excavations or tombs are generally cut out of the solid rock. About 500 yards eastward from the Hall of Columns, in the face of the mountain, is found a niche seventy-two feet in breadth by a hundred and thirty feet in height, divided into two compartments, and covered, as usual, with sculptures of non-descript animals, royal personages, and symbolical figures. Three quarters of a mile southward from Tackt-e-Jumsheed, a tomb was discovered by Niebuhr, and visited by Morier, which seemed to have no entrance, from which he supposes that those receptacles for the dead were entered by subterranean passages. The sepulchres of Naksh-e-Roostum, which have been visited by various European travellers, are also very curious. There are four excavations cut out of the perpendicular cliff, at the height, according to Sir R. K. Porter, of sixty feet from the ground. The one he examined, and to which he was drawn up by ropes, consists of an excavation in the solid rock of about fourteen feet, in the form of something like a Greek cross. The length of the cave, which forms the whole tomb, is thirty-four feet, and the height nine. It is adorned, like all the other ancient monuments, with a variety of richly-sculptured figures of men and animals, and emblematical devices. There are likewise numerous remains of antiquity in the plains of Mourghab, forty-nine miles north-north-east of the ruins of Persepolis, and probably belonging to the same era, which are fully described by Morier and Porter. The most remarkable of these is the supposed tomb of Cyrus; an interesting monument, of which the latter writer gives an account with his usual accuracy. It is surrounded by other ruins, which bear traces of the same antiquity, as they contain numerous inscriptions in the ancient arrow-headed character.

The sculptures on the mountain called Be-Sitoon are very curious, and have attracted the particular attention of travellers. This mountain, or rather abrupt precipice, is the termination of the rugged ridge that bounds the plain of Kermanshah on the north. It is 1500 feet in height, and the lower part has been smoothed to the height of 100 feet, and to the breadth of 150, leaving a projection both above and below, the latter sloping gradually in a rocky terrace to the level of the ground. No relics of any column have ever been found here; and hence the name Be-Sitoon, "without pillars." Just over the fountain-head of a beautifully clear stream, which bursts from the mountain about fifty yards from this rocky platform, are seen the remains of an immense piece of sculpture, so greatly defaced that no continued outline can now be made out; but by close examination the rude forms of several colossal figures may be traced. The principal cause of the mutilation seems to be that additions have been made to the original. In one place a Greek inscription has been introduced, and has, in its turn, been erased to make way for one in Arabic. Those rude sculptures are generally supposed to be of high antiquity, some referring them to the age of Semiramis. Above these appears an interesting piece of sculpture, containing fourteen figures, one of a king trampling on a prostrate body, probably of some of his captives. He has a diadem and all the other badges of sovereignty; and a row of nine persons having their hands bound behind them, and being themselves bound together by a cord round their necks, are seen approaching him in a suppliant posture, and with a dejected expression. Sir R. K. Porter supposes, apparently not without reason, that these ten persons, including the one under the feet of the monarch, represent the ten tribes which were carried into captivity; and that the design of the sculpture, which is executed in a style not inferior to any at Persepolis, is to commemorate the final conquest of Israel by Salmanaser, king of Assyria and the Medes. Above the head of each individual is a compartment with an inscription in the arrow-headed writing, probably descriptive of the design of this sculpture, and the personages contained in it. Hitherto, however, the learned in Europe have not been able to decipher this ancient writing; and hence the meaning of these and many other ancient monuments must still remain concealed under the mysterious veil of these unknown characters.

There are other antiquities in Persia that belong to the later period of the Sassanian dynasty, of which it may be proper to give here a brief notice. The most remarkable of these monuments are the sculptures at Tackt-i-Bostan, or the throne or arch of the garden. The mountain in which these are seen forms part of the chain of the Be-Sitoon; and, like it, is craggy, barren, and of the most rugged aspect. A remarkably clear stream bursts forth from the base of this mountain, and just over its source a bas-relief presents itself; and a little onward a flight of several hundred steps is found cut in the nearly precipitous cliff, finishing abruptly in an extensive ledge or platform. Beneath this platform are situated two arches, the largest of which is twenty-four feet in width, and twenty-one in depth. Above the sweep of the arch the face of the rock has been smoothed for a great distance, and also on each side; and on this surface there are two upright entablatures, containing an exquisitely-finished ornament of foliage, in the Grecian taste. Round the bow of the arch runs a double border, terminating in the Sassanian royal streamers. Over the key-stone of the arch is a crescent, supported on each side by the same regal insignia. Two gigantic female figures with wings appear hovering over the curves of the arch, and both extend their hands towards the crescent, each holding a diadem with a rich clasp, and waving ribbons, the usual emblems of the Sassanian dynasty. The inner face of the excavation is divided into two compartments, the upper containing three figures, on the left a female with a royal mantle and collar, and crowned with the peculiar diadem of the Sassanian princes. The gorgeous habit of the central figure, and the pointed diadem on his brow, with wings on each side that twist round the crescent surmounting the diadem, within which rises a globe, and the double waving streamers, proclaim him to be of royal dignity. He wears a short robe embroidered with pearls, a breast-plate of the same costly materials, and loose trousers over his ankles; and his left hand rests upon a sword, which, along with the belt that binds it, is covered with pearls. The figure to the right also wears a crown, but without the wings, the crescent, and the globe of the central figure. To this figure he is in the act of presenting a diadem, which the open hand of the monarch appears ready to grasp. These figures are all elevated upon rich pedestals. The lower compartment contains a colossal equestrian figure in alto-relievo, clad in a shirt of mail beautifully carved, and falling nearly as low as the knees. There are here traces of a Greek and of a Pehlavi inscription, both illegible. On the other sides are delineated a boar and a stag hunt, in the minutest detail.

The second arch is nine feet in width and twelve in depth. It contains, in the back of the recess, only two figures, similarly habited with the others, having the balloon-shaped cap, curled hair, and rich robes. On each side of the figures are found two inscriptions in the ancient Pehlavi character and language, which have been deciphered by the singular ingenuity and learning of the French academician De Sacy, and are as follow. The first inscription runs thus: "This is the figure of the adorer of Ormuzd, the excellent Shapoor, king of kings, of Iran and An-Iran, celestial germ of the race of gods, son of the servant of Ormuzd, the excellent Hoormuz, king of kings, of Iran and An-Iran, celestial germ of the race of gods, grandson of the excellent Narses, king of kings." The second inscription is as follows: "He of whom this is the figure is the adorer of Ormuzd, the excellent Vaharam, king of kings, of Iran and An-Iran, celestial germ of the race of gods, son of the servant of Ormuzd, the excellent Shapoor, king of kings, of Iran and An-Iran, celestial germ of the race of gods, grandson of the excellent Hoormuz, king of kings."

There are other monuments of antiquity both at Shapoor and at Persepolis, which belong to the era of the Sassanian kings, and which afford important and curious illustrations of these times. Fifteen miles north of Kauzeroon are the ruins of Shapoor, once the capital of Persia. At the entrance of the valley where it is situated stands an insulated hill, which exhibits portions of its ancient walls and towers; and the precipitous cliffs are carved with sculptures. On the southern side of the river which waters the plains, a much mutilated bas-relief is carved on the surface of the rock, consisting of two colossal equestrian figures. Their height appears to be about fifteen feet. A tablet, divided into three compartments, contains the second sculpture. In the central compartment is an equestrian figure, with the usual badges of Sassanian sovereignty. A suppliant is on his knees before the horse's head, his hands extended, and his face expressive of entreaty; whilst another figure with Egyptian features stands, likewise in the attitude of a suppliant, to the right of this compartment. The right-hand section contains three figures in attitudes of supplication. A greater number of tablets are still to be seen on the opposite side of the river. They contain various figures and designs, one of which is an elaborate representation of the triumph of a Persian over a Roman army. Colossal horsemen are pictured on others, with the royal emblems of Persia. In the Shapoor valley is a mountain, which is crowned by a perpendicular precipice of limestone 700 feet in height. Here is a cavern of enormous extent, its communication intricate and endless, with every form and variety of stalactites diversifying the different chambers, some of which are wonderfully lofty and spacious, and, when entered by torch-light, present the most brilliant reflection of all sorts of fantastic shapes. The entrance to the cave is about 140 feet above the base of the precipice; and here, in a spacious archway a hundred and fifty feet broad, and nearly forty feet in height, within which is a sort of natural anti-chamber, stands the pedestal of a statue, which lies mutilated and prostrate with the head downwards. Both have been cut out of the solid rock. The figure, which, when erect, must have been from fifteen to twenty feet in height, represents some one of the Sassanian kings, Shapoor as is supposed. There are various other Sassanian relics in the vicinity of Persepolis, namely, the tombs of the kings, where the sculptures, by the natives called Naksh-e-Roostum, are to be found; also the sculptures named Naksh-e-Rejib. The sculptures of Naksh-e-Roostum are contained in six tablets cut on the perpendicular rock, and containing many bas-reliefs of the triumphs or victories of the Persian arms under the Sassanian kings, with figures of the sovereign in various attitudes, and of horsemen engaged in hostile collision. The sculptures at Naksh-e-Rejib consist of three tablets, containing seven colossal and two diminutive figures. One of the sovereigns is on horseback in his greatest pomp, and underneath is a Greek inscription, which has been restored and translated by M. de Sacy. It runs thus: "This is the resemblance of the servant of Ormuzd, the divine Shapoor, king of kings, of Iran and An-Iran, of the race of the gods, son of the servant of Ormuzd, the divine Artaxares, king of kings, of Iran and An-Iran, of the race of gods, grandson of the divine Babec the king." The remaining tablet contains but a repetition of the two horsemen holding a ring.

There are other ancient monuments in different parts of Persia, consisting of sculptured rocks and other remains resembling druidical erections. For a particular account of these and the other relics of antiquity, which we have here briefly described, the reader is referred to Niebuhr, Chardin, Morier, Sir W. Ouseley, Sir R. K. Porter, and others. The sketch that we have given will suffice to illustrate generally the nature, as well as the beauty and art, which appear in these antiquarian remains.

The early history of Persia is lost in remote antiquity, and for authentic accounts the most extravagant fables have been substituted. These are chiefly the uncertain gleanings of oral tradition, or the fictions of poets. The work of Ferdousi, celebrated as the Homer of Persia, which, from the rudest materials, is amplified into a history of the Persian kings, comprises all the information possessed by the Asiatic writers prior to the Mahommedan conquest; nor are the prose chronicles of a later date one whit more authentic than the reveries of the poets. From these authorities Sir John Malcolm has compiled the early annals of Persia, to which we refer our readers for some account of that barbarous era. Arbaces is generally considered as having been the first sovereign of Media. He flourished in the year 747 before Christ, and conspired with Balesis, governor of Babylon, and other nobles, against Sardanapalus, with whose death terminated the Assyrian monarchy. Dejoces is by other writers held to have been the first sovereign of Persia. He was succeeded by his son Phraortes, who swayed the Persian sceptre twenty-two years. Learned writers have exercised their ingenuity to reconcile the names and dates of this obscure portion of Persian history. But amidst such manifold obscurities speculation seems to be useless, the truth being lost beyond the hope of recovery. The conquest of the country by Cyrus is the first era of Persian history which has the appearance of authenticity. Cyrus was the chief of a pastoral horde, who, quitting their own comparatively barren and unproductive country, subdued the territories of their wealthy and luxurious neighbours. He was the conqueror of Babylon; and on the ruins of that great kingdom he founded that of Persia, which was gradually extended by conquest from the Mediterranean to the Indus and the Oxus. Historians differ concerning the fate of this monarch. According to some, he was taken prisoner and put to death by the queen of the Massagetæ; whilst Xenophon affirms that he died in Persia, and was buried at Pasargada, in the year 529 before Christ. Cyrus was succeeded by Cambyses, the Ahasuerus of the Scriptures, who gave himself up to sensuality and cruelty. Still he extended his empire, having reduced Egypt to the state of a colony, and also conquered a great part of Northern Africa. Pseudo Smerdis, feigning himself to be the brother of Cambyses, who had been murdered, was by a faction of the Magi raised to the throne. Otanes, a Persian nobleman, finding out the deceit, conspired with six other chiefs, who agreed to assassinate him, which they effected, after he had reigned eight months. Along with him they put to death a number of the wise men; and, having decided on a monarchical form of government, they resolved to assemble next morning at sun-rise, without the city, on horseback; and it was agreed that he whose horse should neigh first should be chosen king. The well-known trick of Æbores, the groom of Darius Hystaspes, secured the throne to his master. He brought his master's horse the evening before, with a mare, to the appointed spot; and the horse, as soon as he arrived next morning, recollecting the mare, neighed, and he was immediately saluted king. It was during the reign of this monarch, who, according to Sir John Malcolm, is the king named Gushtah by the Persian historians, that the worship of fire was introduced into Persia by Zoroaster. The founder of this new religion is generally supposed to have lived during the reign of this prince, who was converted by his arts to the new faith, and who not only built temples for the worship of fire in every part of his dominions, but compelled his subjects to worship in them. The new faith, accordingly, spread rapidly, and its precepts were ordered to be written on 12,000 cow-hides, tanned fine for the purpose, which were deposited in a vault under the guardianship of holy men. Darius Hystaspes reigned over Persia sixty years, and was distinguished as a legislator as well as a conqueror. He divided the country into nineteen satrapies or provinces, each liable for the payment of a fixed tribute. Over these provinces satraps were sent to preside, with the delegated authority of the king. Their duties were to collect the revenue, to improve agriculture, and to perform all the royal commands. They were afterwards invested with military commands; and securities were devised against their usurpation of independent authority. An establishment of couriers was at the same time instituted, for expediting orders through every part of the empire. A regular and efficient military force was also organized by this monarch, and maintained at the expense of the different provinces. In process of time, Grecian mercenaries were taken into pay; and, when the country was engaged in war, the army was recruited from the people.

The reign of Darius was distinguished by several important warlike expeditions. Crossing the Thracian Bosphorus, he invaded Europe with 70,000 troops. But the Scythian tribes between the Danube and the Don successfully resisted his attack, and forced him to retreat with loss. He then overran the territories of Thrace and Macedonia, and thus began those attempts on the independence of Greece which were fraught with such disgrace to the Persian arms. He invaded the countries to the east of Persia with a powerful army, and added several extensive and rich provinces to his already overgrown empire; and his vast armies were also sent to overwhelm the rising communities of Greece. But his troops, though they far outnumbered their enemies, were here opposed by a firm and disciplined band of devoted patriots; and they were completely overthrown on the plains of Marathon by the forces of the Greeks, as inferior in number as they were superior in valour, in patriotism, and in every heroic quality. Amidst these disasters the reign of this monarch terminated, and he was succeeded by his son Xerxes.

The latter carried on a successful war against the Egyptians, whom he gave over to the vengeance of his brother Achæmenes; and he resolved to avenge himself on the Greeks, who had hitherto bravely defended their country against the numerous armies of Persia. With this view he fitted out a mighty armament, in which he embarked an army amounting to three millions of troops, or, with all the camp followers, to above 5,000,000; and with this vast force he resolved to annihilate the independence and liberties of Greece at a single blow. But he was met by the devoted bands of Grecian patriots, and experienced a severe check at the celebrated pass of Thermopylæ, which was defended by 300 Spartans against his whole army, and which he only carried by an immense sacrifice of men; and his fleet and army were finally overthrown at Salamis, Platæa, and Mycale, he himself escaping from the scene of action in a miserable fishing-boat. He was assassinated, after a reign, as some say, of twenty-one, or, according to others, of sixty years. But Sir John Malcolm is of opinion that this period includes also the two former reigns.

He was succeeded by his grandson Artaxerxes Longimanus, the Ardisheer Dirazdust or Long-shanks of the Persian historians. He is celebrated for the internal regulation of his empire, and for the intelligence which he acquired relative to all the concerns of the kingdom, by means of the agents whom he employed. He is represented by some as the Ahasuerus of the Scriptures, because he is said to have treated the Jews with lenity and kindness, and to have married one of that nation. But this is doubted by many, and does not well agree with other historical facts. This period of the Persian history is peculiarly obscure; and Sir John Malcolm observes, that the authors whom he follows become more fabulous as the history advances. The two succeeding sovereigns were Xerxes II. and Darius II., whose reigns were short. The latter was succeeded by Artaxerxes Memnon, his eldest son, who had to contend for the crown with his younger brother Cyrus. It was in his reign that the famous retreat of the ten thousand took place under Xenophon, who has given a narrative of the expedition. His reign, which continued twenty years, was a scene of intrigue, in which favourites bore the chief sway, and during which those symptoms of decay became visible which terminated at last in the overthrow of the kingdom. He was succeeded by Darius or Dorab I., who reigned only twelve years. In the year 336 B. C., Darius Codomanus, or Dorab II. of the Persian historians, assumed the sceptre; but he was totally unlike his father, being deformed in body, and not less so in mind. It was in his reign that Alexander of Macedonia, having subdued the different principalities of Greece, and consolidated their power into one, invaded Persia. He crossed the Hellespont in the year 334 B. C., with a well-disciplined and veteran force of 35,000 men, and encountered and defeated the Persian host on the banks of the Granicus. The hasty levies of Persia were again routed in the fatal battle of Issus, in which 100,000 were slain; and the family of Darius fell into the victor's hands. The battle of Arbela, which succeeded, completed the triumph of Alexander. The Persian armies were routed and dispersed, and the unfortunate Darius, flying from the field of battle, was seized by his nobles, at the head of whom was Bessus, who bound him in golden chains, and were carrying him to Bactriana in a car covered with skins; but being overtaken by the conqueror, they stabbed their victim to the heart, and left him in the chariot, weltering in his blood. He was found in the agonies of death by Polystrates, a Macedonian. The unhappy king asked for water, and with his last breath implored blessings on the head of Alexander, for his kindness to his wife, his mother, and his children. "Present," said he to Polystrates, "your hand to Alexander, as I do mine to you, the only pledge I have to give of gratitude and affection." The Greek and Persian accounts of the death of Darius do not materially differ, only that the latter are embellished by many circumstances, and also by fables, not related by the Greek or Roman historians. The body of the deceased king was embalmed with musk and amber, wrapt in a cloth of gold, and placed in a rich coffin adorned with jewels, and was in that state carried to the sepulchral vault, and interred with extraordinary honours. Exemplary justice was then executed on Bessus, the murderer of Darius, who, according to some, was hanged, but, according to others, torn in pieces by means of trees, which, being bent in a particular manner, were allowed to spring back to their natural position, and in this manner tore his body, which was fastened to them, in pieces. With Darius terminated the dynasty of Cyrus, which had subsisted 206 years under the following series of kings, as given by the Greek writers, with the periods of their several reigns. There is, however, no corresponding series given by the Persian historians, nor indeed any agreement between the narratives of the historians of the respective nations.

Greek Names of the Persian Kings.

Names.	Reigns.	Names.	Reigns.
1. Dejoces	53	10. Artaxerxes Longimanus	49
2. Phraortes	22	11. Darius Nothus	19
3. Cyaxares	40	12. Artaxerxes Memnon	46
4. Astyages	35	13. Ochus	21
5. Cyrus	30	14. Arses	2
6. Cambyses	25	15. Darius Codomanus	5
7. Smerdis the Magian	7		
8. Darius Hystaspes	36		
9. Xerxes	21		
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After the death of Alexander, Asia continued for a long period a scene of war and commotion, owing to the contests which arose amongst his successors for the dominion of the country. But about the year 307 B. C., Seleucus by his success had acquired the dominion of all the countries which lie between the Euphrates, the Indus, and the Oxus, and he had even carried his victorious arms to the Ganges, and established a friendly alliance with Sandrocottus, one of the sovereigns of these eastern countries. The Seleucidæ continued to sway the sceptre of this kingdom till the year 250 before the Christian era, when they were expelled from the throne by a successful revolt of the Parthians, who succeeded in establishing a new dynasty of kings. This revolution was effected by Arsaces, a noble of that country, who had been enraged by an affront offered to his brother Tiridates. Having assembled his friends, he put the tyrant to death; and, encouraged by his success, and by his increasing popularity, he openly aspired to the throne. He was mortally wounded, however, in a successful battle, in the moment of victory. His crown was inherited by his brother Tiridates, who laid the foundation of the Parthian dynasty. The Arsacidæ, as they are termed, from their founder, continued to rule in Persia for 430 years, namely, till the 230th year of the Christian era. The Persian annals during the whole of this period are very imperfect, and, according to Sir John Malcolm, that remarkable era of five centuries, from the death of Alexander till the reign of Artaxerxes, may be termed a blank in eastern history. The Parthian line of kings were illustrious, however, by their deeds, recorded in the authentic pages of the Greek and Roman historians. The Parthian empire extended, under its sixth monarch, Mithridates I., from the Euphrates to the Indus, and its monarchs were the only potentates who maintained a successful conflict with the Roman power. Pacorus, the ninth of the Arsacidæ, was the first Parthian king who had any intercourse with Rome. In the ninetieth year before the Christian era, he despatched an embassy to Sylla, at that time the Roman commander in Cappadocia; and it was thirty-seven years afterwards that the Roman troops under Crassus were destroyed by the Parthians. The Romans were not aware, until they were instructed by fatal experience, of the advantages possessed by the Parthians for defensive war, first, in the nature of their frontier, which from the Caspian Sea to the Persian Gulf presents a barrier of lofty mountains, rapid and broad streams, or wide-spreading deserts; and, secondly, in their peculiar tactics, by which the Parthian warrior took an unerring aim whilst he was retreating from his enemy. The Roman legions, surrounded, amidst those barren wastes, by clouds of cavalry, perished by the arrows of an enemy whom they could never reach. "The system," says Sir John Malcolm, "was suited to the soil, to the man, and to the fleet and robust animal on which he was mounted; and its success was so certain, that the bravest veterans of Rome murmured when their leaders talked of a Parthian war." The Parthians were so much elated with their victory, that they invaded and overran Syria and Asia Minor, and were at last overthrown by the Roman legions under Ventidius, the general of Antony. The latter, however, in an expedition undertaken against the Parthians in revenge for the defeat and death of Crassus, narrowly escaped the same fate; he succeeded, however, after a long and painful retreat, in placing the deep and rapid river of Aras or Araxes between him and the pursuing enemy, and thus effected his escape. Augustus, after he was seated on the imperial throne, threatened an invasion of Parthia. To avert this attack, Phraates, the fifteenth of the Arsacidæ, restored the standards which had been taken from Crassus. During the whole remaining period of this dynasty, which amounted to 200 years, the Romans were often at war with the Parthians; but they made no serious impression on their territories. Macrinus was involved, by the perfidy of Caracalla, whose successor he was, in a long and bloody war with the Parthian monarch Artabanes, who, after the war had terminated, as usual, by a treaty, was so weakened by his losses, that Artaxerxes, a Persian nobleman of great courage and influence with his countrymen, availed himself of the hereditary animosity of the Persians to stir up a rebellion against him. Arsaces took the field in defence of his crown, but was defeated in three battles, taken prisoner, and put to death, after which his rival ascended the throne, A. D. 226 ; and thus terminated the dynasty of the Arsacidæ, of whose line of kings a list is subjoined.

Dynasty of the Arsacidæ.

1. Arsaces I.
2. Tirides his brother.
3. Arsaces II.
4. Preapatius.
5. Phraates I.
6. Mithridates I.
7. Phraates II.
8. Artabanes I.
9. Pacorus I. who sent ambassadors to Sylla.
10. Phraates III.
11. Orodes I.
12. Mithridates II.
13. Phraates IV.
14. Phraatices.
15. Orodes II.
16. Venones I.
17. Artabanes II.
18. Tiridates.
19. Bardanes.
20. Gotarzes.
21. Miherdates.
22. Venones II.
23. Volgeses I.
24. Artabanes III.
25. Pacorus II.
26. Chosroes.
27. Parthanaspates.
28. Volgeses II.
29. Volgeses III.
30. Artabanes IV.

The Sassanian dynasty of kings forms a new era in the history of Persia. These monarchs were engaged in long and bloody wars with the Roman emperors ; and hence we are enabled to correct the imperfect records of the East by the authentic narrative of the Roman historians. The new monarch Artaxerxes, or Ardisheer as he is called by the Persian historians, having pacified the province of Fars, made himself master of Irak ; and having defeated and slain Aravan or Artabanes, who ruled over the mountainous country about Hamadan and Kermanshah, he was hailed in the field with the high title of Shah an Shah, or king of kings ; a name which has ever since been assumed by the sovereigns of Persia. In the course of his reign, which lasted fourteen years, he extended and consolidated his newly-acquired dominions, and waged, with various success, a war with the Roman emperor Alexander. He laboured to restore the religion of Zoroaster, and the authority of the Magi, which he enforced against all who opposed it, by the most sanguinary decrees. He was succeeded by his son Shapoor or Sapores, A. D. 242, who carried on a successful war against the Romans, whose emperor, Valerian, in an attempt to relieve Edessa, was defeated and taken prisoner. He gained many victories over the armies of that nation ; but towards the latter part of his reign he suffered reverses; his army was attacked by Odenathus, prince of Palmyra, and his country was afterwards invaded by Aurelian, the warlike emperor of Rome. Hoormuz his son, the Hormisdas of Greek authors, reigned only one year, and was succeeded by Baharam or Varanes, who evinced his zeal for the ancient religion of Persia by the execution of Mani, the founder of the sect of Manicheans. He reigned three years and three months, and was succeeded by Baharam II., who was a weak prince. During his reign of seventeen years, he engaged in a war with the Roman emperor Carus, who conquered Mesopotamia, carried his arms across the Tigris, and made himself master of Ctesiphon. Baharam III. reigned only three months. His brother Narsi (the Narses of the Greeks) reigned nine years, and abdicated the throne in favour of his son Hoormuz. He subdued Armenia, and signally defeated the Emperor Galerius on the same fatal field on which Crassus had been slain. The Romans invaded Persia next year, and defeated, with great slaughter, Narses, who fled, leaving his tents and family in possession of the conquerors. An inglorious peace followed, by which Mesopotamia and five districts to the eastward of the Tigris were ceded to the Romans. No events of any consequence occurred during the succeeding reign of Hoormuz II. the Misdates of the Greeks. He was succeeded by Shahpoor II. or Sapores, who was crowned king from his birth, and during a reign of seventy years maintained the integrity of his kingdom. His first operations were directed against the Arab tribes, on whom he took a severe vengeance for having invaded his territories. He was involved in bloody wars with the Romans, in the course of which he experienced serious reverses. Constantine advanced into Persia with a formidable army, and was joined by the Arab forces. A dreadful conflict took place, in which the Persian army was routed with great slaughter, and the king himself narrowly escaped, with a few followers, from the fatal field. But having recruited his army, he again took the field, and, in a night attack, he recovered some of the advantages which he had lost. He was also successful in repelling the invasion of Julian, who was killed by an arrow, and his successor Jovian was fain to purchase a peace by the loss of all the provinces east of the Tigris, which had been ceded in the former reign. Shahpoor reigned during his whole life, which was seventy-one years. Ardisheer II., or Artaxerxes, succeeded, and was deposed by Shahpoor, the son of the late monarch, after a reign of four years. He reigned only five years, when he was killed by the fall of a tent, which was blown down by one of those whirlwinds which sometimes occur in Persia. Baharam IV. or Varanes, who succeeded, reigned eleven years, and was at length killed by an arrow, in endeavouring to quell a tumult in his army. The throne of Persia was next filled by Yezdijird, the Greek Isdigertes. He is very differently represented by the Persians and Greeks ; by the former as cruel and abandoned to luxury, and by the latter as wise and virtuous. He was killed by a kick of his horse, after a reign of sixteen years. Baharam Gour, or Varanes V. succeeded. He is celebrated for his munificence and generosity. His dominions were invaded, and partly overrun, by the Tartars, who, being flushed with their conquest, gave themselves over to a false security, and were one night surprised and defeated with great slaughter by Varanes. The only fruit which he sought from this victory was peace with all his neighbours, after which he returned to his capital. He was engaged in wars with the Romans under Theodosius, in which neither party had any cause to boast. His ruling passion was the chase, and he was fond of hunting the wild ass ; and it was in pursuit of one of these animals that he lost his life, in a deep pool, where neither he nor his horse were ever again seen. He was succeeded by his son Yezdijird II., or Varanes VI., who followed his father's footsteps, and, during his reign of eighteen years, was only once engaged in war with the Romans. The succession to the throne was now disputed between Hoormuz (Peroses) the younger son of Yezdijird, who was appointed heir by his father, and Ferose (Varens IV.) the elder, who, being supported by an army of Tartars, to whose king he fled for support, and by the chief nobles, succeeded in wresting the sceptre from his brother's hand, and in putting him to death, after reigning a year. He lost his life in an expedition which he undertook against the Tartar prince, by whom he had been treated with so much generosity. Pallas, the son of Ferose (Cavades), now ascended the throne, and was succeeded by Kobad, who, though he was dethroned by his discontented subjects, reconquered his lost dignity. He carried on a successful war with Anastasius the Roman emperor, and died after a long and diversified reign of forty-three years.

His son and successor Khosroo Nooshirvan is celebrated by the Persian historians as a model of justice, generosity, and sound policy. He ascended the throne A. D. 531. He is said to have been the fruit of a casual amour of Kobad, who, flying from his brother Ferose, then established on the throne, halted for a night with a beautiful girl at Nishapore. Four years afterwards, on his return to that city, his fair mistress presented him with a boy, who was one day to reign so gloriously on the Persian throne. His first care after his accession to the sovereignty was to extirpate the pernicious sect of Mazdak, encouraged by his father, one of whose leading tenets was a community of property and of women. He had recourse to severe measures. The founder of the sect and many of his followers were put to death; and the women and property which they had appropriated were restored to those to whom they belonged. He was indefatigable in promoting the prosperity of his dominions, in building and repairing bridges, in restoring and repeopling decayed towns and villages, in founding schools and colleges, and in giving every degree of encouragement to learned men, and even to the Greek philosophers who resorted to his court. His empire was divided into four great governments, namely, 1*st*, Khorassan, Seistan, and Kerman; 2*d*, the lands dependent on the cities of Ispahan and Koom, the provinces of Gheelan, Azerbijan, and Armenia; 3*d*, the provinces of Fars and Ahwaz; and 4*th*, Irak, which extended to the frontier of the Roman empire. A well-digested system of provincial government was introduced into those provinces, and every check adopted that could prevent the abuse of power. He imposed a fixed and moderate land-tax over all his dominions, and a capitation-tax on the Jews and Christians; and the strictest regulations were adopted for preserving the discipline of his army. The reign of Nooshirvan was illustrated as well by his conquests abroad as by his wise policy at home. He compelled Justinian to conclude a disgraceful peace at the price of 30,000 pieces of gold; and the reduction of Syria, the capture of Antioch, and the advance of the Persian armies to the shores of the Mediterranean, attest his triumphant reign. Though he was checked in his career of conquest towards the west, yet his sway was finally extended over the countries beyond the Oxus, over those to the south of the Indus, some provinces of India, and the finest districts of Arabia. He reached the advanced age of more than eighty years.

Hoormuz III. the Chosroes of the Greeks, was declared the successor of Nooshirvan his father. His administration was wise and prosperous for a time, whilst he acted under the advice of his preceptor; but on the death of the latter, he fell into every excess, and, after a short and disastrous reign, was dethroned and put to death by one of his generals, Baharam Choubeen, who usurped the supreme authority. But Khosroo Purveez (Hormisdas), the son of the late king, flying to the Roman emperor Maurice, his adopted father, was, by his assistance, reinstated in the throne, and Baharam was forced to seek refuge amongst the Tartars, whose armies he had formerly defeated, and amongst whom he died. The new monarch showed his gratitude to the Roman emperor by scrupulously fulfilling all the engagements he had contracted with him. He surrendered Dara and several other strong places on the frontier, and, besides, sent him costly presents. But no sooner did he hear of the death of Maurice, than he invaded the Roman territories with a large army; pillaged and destroyed Dara, Mardin, Edessa, and Amida; laid waste Syria; took the holy city of Jerusalem; and set on fire the magnificent churches of St Helena and Constantine. The true cross, which had been enclosed in a golden case, and buried deep in the earth, was discovered and borne in triumph to Persia; and a crowd of captive priests and bishops swelled the train of the conqueror. Egypt was added to his other conquests; his troops entered Alexandria in triumph; and, after carrying his victorious arms westward to Carthage and Tripoli, and finally extirpating the Greek colonies of Cyrene, he returned in triumph through the sands of the Libyan desert. In the same campaign another army advanced from the Euphrates to the Thracian Bosphorus; and, after taking Chalcedon, his victorious troops remained encamped for twelve years in the vicinity of Constantinople. But, whilst his general and his armies were thus gaining laurels in the field, Khosroo was indulging at home in the most unheard-of luxury. Every season a splendid palace was raised; and his thrones were made of the most exquisite materials, one being formed to represent the twelve signs of the zodiac and the hours of the day. His treasures; his wives, amounting to 12,000, besides the incomparable Shereen, of whom he was passionately fond; his horses, amounting to 50,000; his Arabian charger of surpassing fleetness; and his musician Barbud; furnish inexhaustible topics for the pen of the historian, and for the hyperbolical praises of his countrymen. But his reign, hitherto glorious, was, towards its termination, closed with misfortunes. Herodius, the Roman emperor, alike remarkable for luxury and indulgence in the palace and for valour and military skill in the field, was roused to a sense of the public danger by the victories of Khosroo, and with a powerful army suddenly invaded Persia. In the course of six years, he succeeded in stripping the Persian king of all his foreign conquests; he defeated his armies in every encounter; marched without opposition into the heart of his country; destroyed his splendid palaces, and plundered his hoarded treasures. His subjects, headed by his own son, at last rebelled against him, and put him to death, after a reign of thirty-eight years. Persia, after the death of this prince until the accession of Yezdijird III. (the Isdigertes III. of western writers), was a scene of confusion and misery, from the combined evils of famine, the contentions of the nobles, a succession of weak sovereigns, or rather, as Sir John Malcolm terms them, pageants of power, and from the threatened attack of the Arabian tribes, who, under the standard of the Mahommedan faith, had now become very formidable to all surrounding states. In their first attacks on the Persians, the Moslemin armies were repulsed, and their leader Abu Obeid was slain. The Arabs, reinforced, were again defeated by Mehran the Persian general. But in another action the Persians were defeated, and their general slain. Yezdijird, who was now elevated to the throne, was the last hope of the sinking state. An ambassador was sent to him from the Arabian tribes, proffering peace on condition that he should accept of their religion, and pay the taxes which all believers are bound to pay. These terms were rejected with disdain. Great armies were now assembled on both sides; they met on the plains of Nahavund, A. D. 641, where the Mahommedans gained a remarkable victory, that for ever decided the fate of Persia. Of the Persians 30,000 perished on the field, and 80,000 more were drowned in a deep trench which surrounded the camp. Persia, from this date, fell under the dominion of the Arabian caliphs. Yezdijird, the last monarch of the Sassanian line, fled from the field of battle to Seistan, to Khorassan, and lastly to Merv, from which being also forced to fly, he concealed himself in a mill eight miles distant. But the miller, tempted by his rich robes and armour, murdered him whilst he slept, and thus ended, A. D. 651, the dynasty of the Sassanides, and the idolatrous worship of the Magi, which had existed in Persia for 1200 years.

After the flight of Yezdijird, the armies of Persia, scattered and discouraged, were able to oppose only a feeble resistance to the hardy children of the desert, skilfully commanded, and, besides, inflamed by a fanatic enthusiasm; and in a short time, accordingly, they very soon overran and laid waste the whole country, with a bigoted fury that had no parallel, sparing neither sex nor age, and subverting in one common ruin the laws, manners, and most sacred institutions of the country. Many were contented to purchase life by embracing the new faith; and others fled to the mountains and fastnesses of the country, or to a distant land. "The progress of the conquerors," says Sir John

Malcolm, "was rapid and wonderful; colonies from the burning deserts of Arabia were extended over the cold countries of Khorassan and Balkh; and they flourished on the soil to which they were transplanted.[1]" The conquest of the country being completed, it was divided into different provinces, over which lieutenants were appointed; and it was thus held for more than two centuries under the dominion of the caliphs. But this system of provincial authority terminated, as usual, with the declining energy of the supreme power, in destruction and anarchy in its subordinate parts. The caliph at Bagdad, from the head of a powerful and warlike tribe, had degenerated into a mere pageant; and as the bonds of authority were relaxed, the different rulers and chiefs of provinces began to throw off their allegiance, and to aspire to independent power. The caliph was merely reverenced as the supreme pontiff; his governors used his name in their public prayers; they were nominally his vassals; but they held the substance, and he had only the shadow, of political power. The sceptre, which was feebly held by the successors of Omar and Ali, presented a tempting prize to aspiring ambition; nor, in the distracted state of the country, was it long before it was claimed and won by an adventurer from the lowest ranks of life. Yacoob-ben-Leis was the son of a pewterer of the name of Leis, in Seistan. He worked, when young, at his father's trade; but he was prodigal of his money; and, tempted by his necessities, he became the leader of a bold and desperate band, which gradually increased with the success of his enterprises. He soon attained power and consideration; and his aid was solicited by Salah-ebn-Naser, the ruler of Seistan, against his fellow-ruler of Khorassan. He was afterwards raised to be commander of Salah's army; and the first use he made of his power was to seize on the chief who had conferred it on him, and to send him to Bagdad; a service for which he claimed and received the government of his native province, as the servant and lieutenant of the faithful. He afterwards took the important fortress of Herat, reduced the province of Kerman, marched thence to Shiraz, and finally made himself master of the greater part of Persia. The caliph, secretly dreading his power, sent him a formal investiture of certain territories as governor, which he rejected with disdain. "Tell your master," said he to the envoy, "I am already indebted to my sword for what he so generously bestows upon me. Let him keep the investiture for some person who will own the obligation, and who is disposed to question my title." He was afterwards engaged in open war with the caliph, when he was overtaken by disease, and died, in 877, leaving almost the whole kingdom of Persia to his brother Amer, who reigned twenty-three years, but was defeated and taken prisoner by Ismail, a Tartar chief with whom he was at war, and, being sent to Bagdad, was there executed. With Amer fell the fortunes of his family; and though two more princes maintained a precarious authority, the empire of Persia was divided between two families, the Samanee and Dilemee. The power of the first extended over Khorassan, Seistan, Balkh, and the countries of Transoxiana, including the cities of Bukharia and Samarcand. The Dilemee princes exercised sovereign power over the greater part of Irak, Fars, Kerman, Kusistan, and Laristan. Of the first-named dynasty Osmael was the most celebrated. His grandfather was a Tartar chief of the name of Saman, who claimed descent from Baharam Choubeen, the Sassanian. He extended his conquests both eastward and westward, and died in 907, at the age of sixty. Asia was at this time the scene of great political revolutions, in the course of which adventurers arose from the lowest ranks; and, having gradually increased their followers, at last acquired sovereign power. It was one of these fortunate chiefs, Abustakeen, that laid the foundation of the great empire of Mahmood of Ghizni. He was one of the chiefs of Bukharia, who having renounced his allegiance to that court, retired to Ghizni with such followers, amounting originally to seven or eight hundred, as he could collect, and there laid the foundation of a petty principality. His son Isaak succeeded him; but he reigning only a short time, the supreme power by unanimous consent was given to Sabactageen, a man of Turkish descent, who, according to some, had been purchased as a slave by Abustakeen, whilst others state, and with more probability, that he was one of the royal guards. He extended his empire by conquest; and when he died, his kingdom extended from Khorassan to the Punjab. Ismail, his younger son, succeeded; but his ambitious brother soon wrested the sceptre from his feeble hand. Ameer Noah, the fifth monarch from Ismail, being hard pressed by his nobles, applied for aid to Sabactageen, who sent his son Mahmoud with an army that overthrew the rebels, and the young prince obtained as a reward the government of Khorassan. Such was the commencement of that great empire of Mahmoud of Ghizni in Persia, which in a few years stretched from Bagdad to Kashgar, and from Georgia to Bengal, and which rose on the ruins of many other subverted empires. He was an enterprising and active prince; and was distinguished by his fanatical zeal, which impelled him to the invasion of India, from which he brought back an immense spoil, valued at twenty millions of dirhems (L.458,333 sterling), 53,000 captives, and 350 elephants, besides jewels to a vast amount. This conquest of India was marked by the wildest rapine and devastation; and his zeal was especially signalized by breaking down and destroying all the idols and splendid temples which were dedicated to idolatry. He died in the year 1208, in a magnificent edifice, to which he had vainly given the title of the "palace of felicity." He was succeeded by Musaood, who was defeated by the Seljuk Turcomans in Khorassan; and in the succeeding reign of Madood, the house of Ghizni lost the whole of their Persian dominions. These Tartar tribes were numerous and powerful; they were a nation of shepherds, inured to fatigue, to long marches, and to every kind of hardy exercise, and trained from their infancy to the use of arms. Their numbers and discipline enabled them easily to overpower the civilized inhabitants of more fertile countries. Accordingly, in the year 1042, the Tartar tribes subdued Khorassan; and their sovereign Togrul Beg, chief of the tribe of Seljuk, assumed in 1389 the state of a sovereign at Nishapoor. In the succeeding twenty years he overran all Persia, made himself master of Bagdad, and took prisoner the sovereign pontiff, the commander of the faithful. He approached him, however, with every outward mark of reverence, and was constituted the temporal lieutenant of the eastern and western divisions of the empire. This alliance was farther cemented by a marriage with the daughter of the caliph. But Togrul Beg, who had by this time attained to his seventieth year, died a few months after the marriage. He was succeeded by his nephew Alp Arselan, the Valiant Lion, who has been praised by all historians for his justice, valour, and generosity. He successfully defended his dominions against an invasion by the Romans; defeated their armies; and having made their emperor prisoner, generously set him at liberty for a fair ransom. He was killed by a rebellious chieftain whom he had ordered to be put to death, but who, having shaken off his guards, assailed him on the throne with all the fury of despair. Alp Arselan, an unerring archer, seized his bow, and commanded his guards to stand aloof; but for the first time his arrow missed its mark, and he fell under the assassin's stroke.

The celebrated Malik Shah, his son, succeeded to the throne; and his reign rivalled, and even surpassed, in glory that of his father. Syria and Egypt were subdued by his victorious generals; Bukharia, Samarcand, and Khauresm yielded to his sway; and he received homage and tribute from the tribes beyond the Jaxartes, and from the distant country of Kashgar. Including the territories of all those princes whom he had conquered, and obliged to do him homage and to pay tribute, his dominion extended from the Mediterranean to the wall of China, and prayers for his prosperity were offered up at the same time in the cities of Jerusalem, Mecca, Medina, Bagdad, Ispahan, Rhe, Bukharia, Samarcand, Ourganjee, and Kashgar. Malik Shah was celebrated as a great and a good prince; the only exception to which is his treatment of Nizam-ul-Mulk, the old and veteran minister of his father and himself. Giving ear to the calumnies of his enemies, he disgraced this faithful councillor, who was soon afterwards stabbed by an assassin hired for this purpose by his successor in office, from a fear of any favourable change taking place in his master's sentiments. Malik Shah survived his minister only a few months, being seized with a violent illness, which terminated his life, in his thirty-eighth year. "The country of Persia," says Sir John Malcolm, "was greatly improved during his reign; many colleges and mosques were built; and agriculture was promoted by the construction of canals and water-courses. Learning was also encouraged; and an assembly of astronomers from every part of Malik Shah's wide dominions were employed for several years in reforming the calendar; and their labours, which established the Jellalean or glorious era, is a proof of the attention which was given at this period to the noblest of all sciences." For thirty years after the death of Malik Shah, Persia was distracted by the wars of his four sons, who contended for the supreme power; but Sanjar, having at length triumphed over his competitors, was elevated to the throne. His reign was for a time successful and prosperous. He resided in Khorassan; and from this spot, as from a centre, his dominion extended in one direction beyond the Indus, and in another to the Jaxartes. Towards the latter end of his reign he experienced the most signal reverses of fortune. Advancing into Tartary, he was completely defeated by the monarch of Kara Khatug, his family were made prisoners, and all his baggage was plundered. He afterwards marched against the Turcoman tribe of Ghuz, who had refused their royal tribute, and in a decisive action which ensued he was defeated and taken prisoner. After being long detained, and cruelly treated, he made his escape, and returned to his own country, where the spectacle of his wasted dominions, ravaged and destroyed by barbarous invaders, so preyed upon his spirits, that he died of melancholy in 1175, at the age of seventy-three. After his death Persia continued during forty years distracted by the wars between different branches of the Seljookian dynasty. The last who exercised sovereign power was Togrul III., who was slain by the monarch of Khauresm, as he went into battle flushed with wine.

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[1] History of Persia, vol. i. chap. viii.

With this prince terminated the race of the Seljookian monarchs in Persia, who from the commencement of the reign of Togrul I. had ruled 158 years. From the decline of this dynasty to the conquest of Persia by Hulakoo Khan, the son of the great conqueror Genghis, the country was distracted by the contests of these rival chiefs, who are known under the name of Atta-begs. They were petty princes, who taking advantage of the weakness and anarchy which prevailed, extended their authority over some of the finest provinces of the country. A detailed account of the progress and decay of these various dynasties would exceed our limits; nor would it contain either amusement or instruction. But there is one chief who requires to be noticed, who may be said to have been the head of a band of assassins devoted to his purposes, and by means of whom he caused the most powerful sovereigns to tremble, and spread far and wide the terror of his mysterious power. His followers were reckoned at 50,000; they were called mysterious and devoted; and each was bound, under the most dreadful sanctions, to sacrifice, at the command of their chief, either his own life or that of another. Hussun Subah was the first of these chiefs. He had been mace-bearer of Alp Arselan; but being displeased with his minister Nizam-ul-Mulk, he retired to Rhe, and afterwards to Syria, where he entered into the service of a chief of the family of Ismail, and adopted their views concerning the right of the descendants of Ismail to the holy dignity of Imaum, instead of the younger brother of Ismail. He afterwards returned to Rhe, his native place, where, leaguing himself with other mal-contents, he succeeded in gaining possession of the mountain fort of Allahamaut, whence he commenced a series of depredations on the surrounding country. Malik Shah Seljookee sent a force against him, which was repulsed. He was soon afterwards exposed to a more serious attack from the Sultan Sanjar, who resolved to extirpate a race whose murders and depredations spread terror over his kingdom. But he was warned to desist from his fatal project, by secret threats of assassination. He had made some marches in the direction of Allahamaut, when one morning as he awoke he discovered a poniard stuck in the ground close to his bed-side, and read with surprise, written on the handle, "Sultan Sanjar, beware. Had not thy character been respected, the hand that stuck this dagger into the hard ground could with more ease have plunged it into thy soft bosom." The warrior who had often faced death in the field of battle trembled at this mysterious threat; and it is certain that he desisted from his meditated attack. Hussun Subah brought several other hill-forts under his sway; and was styled "chief of the mountains," or, as his Arabic title has been erroneously translated, "the old man of the mountain," the name by which he and his descendants are distinguished in the European histories. Caliphs, princes, and nobles, fell under the blows of these assassins; and the power and dominions of Hussun Subah were handed down through a series of sovereigns who ruled for 170 years, the terror and disgrace of Asia, and who in 1256 were finally extirpated by the overwhelming and victorious armies of Hulakoo Khan, who rivalled his sire in the rapidity of his conquests. His first design was to turn his arms against the declining empire of the Greeks; but he was diverted from this object by an astrologer, who directed his hostility against Bagdad, the seat of the caliph's authority. This place was speedily stormed by the Tartar armies, and its inhabitants were put to the sword; the Caliph Mustasim, with his only surviving son, were slain; and thus was for ever extinguished the celebrated empire of the Arabian caliphs. The conquest of Persia, Mesopotamia, and all Syria, was achieved by Hulakoo in the same year, who meditated other ambitious schemes of conquest in the East. But the defeat of his army in Syria by the prince of the Mamelukes in Egypt compelled him to abandon his design; and having restored his affairs in Syria, he fixed his residence at Maragha, a beautiful town of Azerbijan, where he spent his declining years in the cultivation of letters and philosophy. He built an observatory on the summit of a mountain, the foundation of which still remains, "and where," says Sir John Malcolm, "his favourite, Nasser-u-Deen, formed those astronomical tables which have become so celebrated under the name of the tables of Eel-Khannee," and are still referred to for the latitude and longitude of such places as are not fixed by European observations. He was succeeded by Abaku-Khan in the year 1264, who was anxious, by cultivating the arts of peace, to repair the ravages of war, and to heal the still bleeding wounds of his wasted empire. He was assailed from the east by the powerful armies of Tartar chiefs; but he succeeded in repelling all their attacks, and in maintaining the integrity of his empire. He died, it is supposed, by poison, in the year 1281. The Mogul lords having held a council, raised to the throne his brother Neckandar, who, though he was baptized in his youth, afterwards renounced the Christian faith, which he persecuted with all the violence of a renegade, and assumed the name of Ahmed Khan. But his persecution of the Christians was so obnoxious to his own subjects, that they conspired against him, and deprived him both of his crown and of his life. Arghoun, his nephew, whom he had thrown into prison, was raised to the throne by the Mogul nobles, but did not assume the name until he received the investiture from the emperor of Tartary, by whom he was hailed as sovereign of Persia, Arabia, and Syria. His reign was marked by no event of any consequence; and on his death, which occurred in 1291, his brother Key Khaton was raised to the throne by the majority of the Ameers. The latter was indolent, sensual, and extravagant; and his short and inglorious reign would hardly merit notice, were it not for an attempt by an officer of the revenue department, of known talent, to introduce a paper-currency, in order to supply the means of royal extravagance. But credit, the foundation of paper-currency, cannot exist under a despotism which affords no security either for life or for property. The scheme was therefore altogether vain, and appears to have been the device of a tyrant for cheating or plundering his defenceless subjects. From this period until the conquest of the country by Timour or Tamerlane, the history of Persia presents one continued scene of intestine commotion; subordinate chieftains contending for dominion, distraction and violence everywhere prevailing, and the country sinking under the ruthless devastations of war. It is in scenes of trouble and revolution such as these that ambition finds scope for its daring schemes, and that genius, emerging from obscurity, rises, in spite of every obstacle, to its high destiny. Timour the Tartar, or Tamerlane, a corruption of Timour-lung, or Timour the Lame, an appellation derived from an obvious bodily defect, was descended from Korachar Nevian, who had been vizier to Chaghtai the son of Genghis, and also claimed kindred with that great conqueror. The early years of Timour were passed amidst danger and difficulty; and it was in that school that he acquired those qualities which raised him to the sovereignty of the world. He was counsellor and general to the Tartar prince, Ouleaus Khajah, who ruled over the territories between the Oxus and the Jaxartes. But having soon thrown off his allegiance to this prince, he led a wandering life, with only a few faithful followers, enduring hardships and peril, yet never yielding to despair. He had formed a close alliance with Ameer Hussein, one of the most powerful nobles of Transoxiana. Their joint object was to expel the enemies of their country; and Ouleaus, though he had conquered in the field, having been forced to retire with disgrace from the siege of Samarcand, the countries between the Jaxartes and the Oxus were freed from the foreign enemy. A war for the possession of Transoxiana now ensued between Timour and Hussein, and was only interrupted by a short and hollow peace, which terminated in the overthrow of Hussein, who was taken prisoner, and, as is generally believed, put to death, with the secret sanction or by the orders of his rival. Eleven years elapsed before Timour had fully reduced to tranquillity his newly-acquired dominions, and had extended his power over Kashgar and Khaurezm; after which his whole reign was one unvaried course of the most triumphant success. Victory everywhere attended his arms; he subdued cities and kingdoms; strongholds hitherto deemed impregnable yielded to his power; and the devoted countries through which he passed were given up to slaughter and devastation, their towns being sacked, the defenceless people savagely massacred, and vast pyramids of heads raised up as the trophies of his victories. He subdued Khorassan, Candahar, and Caubul, and laid the two latter cities under heavy contributions. He invaded Persia, which, being now ruled by the degenerate descendants of Hulakoo, was entirely barren and wasted. He extended the limits of his empire to the farthest bounds of Tartary; and whilst one body of his troops spread dismay to the wall of China, another army penetrated to the banks of the Irtysch, and a third to the Volga. Timour next marched against Bagdad, which he stormed, and also took the remarkably strong fortress of Takreet; after which his vast armies were dispersed over Asia Minor, Mesopotamia, Kurdistan, and Georgia. He afterwards invaded Russia, and advancing to Moscow, took and plundered that city. Returning to his own country, he prepared for the invasion of India, a particular account of which would be a mere detail of burning and massacre. His war with Bajazet, and his defeat and capture of that warlike chief, were amongst the latest exploits of his active reign; and he had embarked on the arduous enterprise of the conquest of China, when he was arrested by an enemy which he could not conquer. He was seized with a violent illness at the city of Otrar, where he expired in 1405, declaring Peer Mahommed Jehangheer his successor. The latter, however, had a competitor for the crown in Khuleel Sultan, his cousin, by whom he was deposed and murdered; and, in his turn, Khuleel, infatuated by his attachment to the beautiful Shad-ul-Mulk, on whom he squandered the vast treasures of Timour, was deposed by the nobles.

He was attached to the arts of peace, a philosopher, a man of science, and a poet; and his whole care was to heal the wounds inflicted on his country by the wars of the former reign. He rebuilt Herat and Merv, and drew around A.D. 1446. him from all quarters men of literature and science. Sultan Shah Rokh, uncle of Khuleel Sultan, hearing of the misfortunes of his nephew, marched from Khorassan, and his authority was acknowledged over all Transoxiana. Khuleel Sultan was succeeded by Ulugh Beg, who also followed the arts of peace, and neglected those of war. He was deposed and put to death in the year 1449, by his son Abdul Lateef, who was slain by his own soldiers within the short period of six months. The Mogul dynasty in Persia was now fast verging to decay, and its final extinction was preceded, as usual, by scenes of confusion and civil war. The kingdom was at length divided amongst three sovereigns, viz. Sultan Hassein Mirza, a descendant of Timour, who kept a splendid court at Herat, and governed Khorassan; Kora Yussuf, the Turcoman chief of the Black Sheep (the tribes of the Black and White Sheep being so called from their carrying the figures of those animals on their respective standards), ruled over Azerbijan, Irak, Fars, and Kerman; and Uzun Hussoun, chief of the Turcomans of the White Sheep, who finally acquired possession of all western Persia, and attacked the Emperor Mohammed II., from whom he sustained a severe defeat. After his death A.D. 1468. the country was distracted by the contentions of his sons, grandsons, and nephews, for the supreme authority; and their dissensions, whilst they accelerated their own ruin, prepared the way for a native dynasty, which was gladly A.D. 147 hailed by the people as the auspicious omen of domestic peace.

Shah Ismail was the first monarch of the Suffavean line. He traced his descent from Moosa Kauzim, the seventh imaum. The first of the family who attained to any celebrity was Sheik Suffee-ul-Deen, who resided in the town of Ardebil, and from whom the dynasty takes its name of Suffavean, or Suffyean. His son Sudder-ul-Deen inherited all the sanctity of his sire. The great conqueror Timour even condescended to visit him in his cell, that he might receive his blessing; and on his asking whether he, Timour, could do aught for his comfort, "Give up," replied the saint, "those Turks whom thou hast carried off as captives." The disinterested request was granted, the saint was dismissed with presents, and the descendants of these captives ever afterwards acknowledged their gratitude by their ardent support of the Suffavean dynasty. The immediate descendants of Sudder-ul-Deen, Khaujah Ali, Juneyd, and Hyder, acquired also a great reputation for sanctity. The first, after making the pilgrimage to Mecca, visited Jerusalem, where he died. His grandson Juneyd assumed the sacred mantle or patched garment worn by the Suffee teachers, after his father's death; and so numerous were his disciples, that Kara Koinlu, who at that time ruled in Azerbijan, took the alarm, and banished him from Ardebil. He returned to Shirwan, where he was killed by an arrow in a conflict with the troops of that province. He was married to a sister of Uzun Hussoun, chief of the Turcomans of the White Sheep; and this lady was the mother of Sultan Hyder, who succeeded him, and became a warrior as well as a saint. His uncle Uzun Hussoun gave him his daughter in marriage, by whom he had three sons, Sultan Ali, Ibrahim Meerza, and Sultan Shah Ismail. Hyder was defeated and slain in an attack which he made on the province of Shirwan in order to revenge his father's death. Sultan Ali succeeded; but he and his brothers were seized at Ardebil, by Yakub, one of the descendants of their grandfather Uzun Hussoun, who had become jealous of their influence, and confined in a fort, where they remained prisoners for four years. They afterwards made their escape, and were soon joined by numerous adherents. But in the mean time they were attacked, Sultan Ali was slain, and his brothers fled in disgrace to Gheelan, where Ibrahim Meerza died. These events occurred during the infancy of Ismail, the third son of Hyder, of whom we know little till he attained the age of fourteen, when he collected his adherents, and marched against the great enemy of his family, the ruler of Shirwan, whom he defeated. Alwund-Beg, a prince of the dynasty of the White Sheep, hastening with his troops to crush the young warrior, shared the same fate; and the triumphant prince having made himself master of the province of Azerbijan, fixed his residence at Tabriz. Next year he vanquished Sultan Mourad, one of the military competitors for supreme dominion in Persia; and in less than four years from his leaving Gheelan he was acknowledged the sovereign of Persia.

A. D. 1502. Shah Ismail, not being born the chief of a tribe, had no hereditary feuds to avenge; his family were objects of hostility to no one; and he united in his person the reverence and affection of all his subjects. He was a firm adherent of the Sheahs, and of the title of Ali to the caliphate after his uncle Mahommed's death, pitying his misfortunes, and hating with pious zeal, as usurpers of the caliphate, Abubekr, Omar, and Osman, the three first successors of the Prophet, and all their Soonee followers. The Turkish tribes to whom he owed his elevation were highly honoured. They were distinguished by a red cap, from which they received the name of Kuzzilbash, or golden heads, which has descended to their posterity. Persia, Khorassan, Bagdad, and Balkh, submitted to his arms. His territories were afterwards invaded by Sultan Selim about the year 1514, with a numerous and well-disciplined army. In the action which took place, the Persian monarch, after performing prodigies of valour, was entirely defeated, which affected him so deeply that he was never afterwards seen to smile. After the death of Selim he crossed the Araxes, wrested Georgia from the possession of Turkey, and died at Ardebil in the year 1523. He was succeeded by his son Tamasp, who ascended the throne when he was only ten years of age. His reign, which continued fifty-three years, proved prosperous. He repelled the invasions of the Uzbecks on the east, and of the Ottomans on the west. It was from him that Humaiun, emperor of India, when he fled from his rebellious subjects, received the aid which enabled him to regain his throne. It was to him also that Elizabeth sent her envoy, Anthony Jenkinson. But the intolerance of the Mahommedan monarch could not brook the presence of a Christian. His family was numerous; and after several years of disputed succession, and of brief and troubled reigns, Abbas his grandson was proclaimed king in 1582, when a minor. During the earlier years of this monarch's reign, the country was alternately alarmed by internal disturbance and foreign aggression, each party in their turn using the name of the sovereign. But as he advanced to manhood he vindicated his rights, and in the course of three years he reigned the A. D. 15 undisputed sovereign of the country. His reign, which lasted forty-three years, was highly successful and glorious. He was engaged in wars with the Turks and with the Uzbecks, whose armies he defeated in several actions; and it was during his time that an amicable intercourse commenced between Persia and Europe.

Sir Anthony Shirley, a gentleman of family, was persuaded by the Earl of Essex to repair to the court of Persia; and, with twenty-six followers, gallantly mounted and richly attired, he presented himself to the king, who received him with every mark of distinction. The military skill of these foreigners enabled him to discipline his army and to improve his artillery, so that with an army of 60,000 warriors he obtained a decisive victory over 100,000 Turks. In this battle, which was fought on the 24th of August 1605, Sir Anthony Shirley was thrice wounded. After the battle, as Shah Abbas was resting on the field, a man of uncommon stature and of a soldier-like appearance was led past by a youth, who had just made him prisoner. The king having asked who the captive was, the latter replied, "I belong to the Kourd family of Mookree." An officer of the house of Mookree in the service of the king had a bloody feud with the family of the prisoner, and the king commanded the captive to be delivered to him. The officer, however, refused to receive him. "My honour," he said, "calls for blood; but I have made a vow never to take advantage of an enemy who is bound and in distress." The king, irritated by this noble speech, which was a reproof to himself, called to the captain of the guards to strike off the head of the prisoner. The gigantic Kourd immediately broke the cords by which he was bound, drew his dagger, and rushed upon the king. A fierce struggle ensued, in which all the lights were extinguished, and in the darkness no one dared to strike. At last the king exclaimed, "I have seized his hand; I have seized his hand." Order was restored, and lights being brought, the unfortunate captive was pierced by a hundred swords. This victory gave a decided check to the Turks, who were driven from Azerbijan, Georgia, Koordistan, Bagdad, Mosul, and Diarbekir, all of which were re-annexed to the Persian empire. This monarch also entered into an alliance with the English for the destruction of the flourishing Portuguese settlement of Ormuz, which unhappily proved but too successful; and this place, long renowned as the seat of wealth and a great commercial emporium, was plundered and left to decay. Extravagant hopes were entertained in England of the great wealth which was to be derived from a commerce with Persia, and other embassies were fitted out and despatched to the Shah. But these hopes were not realized; nor did they rest on any better foundation than the fanciful descriptions given of these eastern countries by European travellers.

Abbas, considered as an eastern king, may be termed enlightened, and anxious for the good of his subjects. He expended his revenues in the improvement of his dominions, and erecting caravanserais, bridges, aqueducts, bazaars, mosques, and colleges; he embellished Ispahan his capital, and Amshed; and he built splendid palaces, the ruins of which still attest his taste and magnificence. He was also distinguished by his toleration, especially to Christians; and he was liberal in his foreign policy, though his treatment of the inhabitants of Georgia, who were violently transplanted from one district to another, without any regard to their convenience or feelings, was tyrannical in the extreme. He indulged freely in the use of wine, yet he affected extreme piety, every year making a pilgrimage to some particular shrine. To his family he proved a sanguinary tyrant. He had four sons, whom he caressed, whilst in infancy, with parental fondness, but who, as they arrived at manhood, were viewed with jealousy and hatred. The oldest son was assassinated, and the eyes of his other children were put out, by his orders. One of these, Khodahbundah, shut out from the light of day, wandered about gloomy and desperate, brooding over schemes of vengeance against his most unnatural father. He had a daughter, Fatima, innocent and lovely, and the delight of her grandfather, who could not endure that she should be out of his sight. The prince, learning the fondness of his father for this his child, seized her one day with all the fury of a maniac, and deprived her of life. He next directed his frantic fury against his son, who was carried away by the distracted mother. The rage and despair into which Abbas was thrown by the death of his granddaughter gave a momentary joy to the son, who concluded this bloody tragedy by swallowing poison. Abbas died soon afterwards, in 1628, at the age of seventy, worn out with affliction of mind.

By the desire of the expiring prince, Sam Mirzam, one of the sons of Suffee, who had been murdered, was placed on the throne, which he occupied fourteen years. His son Abbas II. succeeded him at the age of ten, and reigned prosperously twenty-five years, though his habits were licentious and intemperate. He was succeeded by his eldest son Abbas in the year 1641, who, under the title of Shah Solyman, reigned twenty-nine years. He was, like his father, the slave of dissolute habits; and his drunken orgies were often stained with blood. He was succeeded by Hussein Mirza, a weak prince, who was ruled by eunuchs and priests, and whose measures tended to destroy the little spirit which yet lingered amongst the nobles and chiefs. The first twenty years of his reign passed over in tranquillity, but it was only the prelude to a political storm. The Afghan tribes who inhabit the mountainous tract between Khorassan and the Indus had long been subject to Persia, and having often suffered great oppression, at length broke out into rebellion, irritated by the tyranny of Gurgeen Khan. The insurgents were headed by Meer Vais, an Afghan chief. They invited the obnoxious governor Gurgeen Khan to a feast, where he was suddenly attacked and put to death; and Meer Vais, collecting his followers, surprised and stormed the fortress of Candahar. He then proceeded to strengthen himself in his newly usurped power. Whilst the weak monarch endeavoured by negotiation to pacify this formidable insurgent, Meer Vais imprisoned his ambassador, and set his power at defiance; and a second ambassador met with no better treatment. The court of Persia now assembled an army under the command of Khusru Khan, who advanced against Meer Vais, defeated his army, and laid siege to Candahar. The insurgent chief having assembled another army, compelled the Persian general to raise the siege of that place, and afterwards defeated him in a decisive action, in which he was slain. In the midst of his successes Meer Vais died, and was succeeded by his brother Meer Abdallah, who was assassinated by Mahmoud, son of Meer Vais. The troubles which now afflicted Persia on every side gave ample leisure to Mahmoud to mature his plans, and to consolidate his power. The Uzbecks were ravaging Khorassan; the tribes of Kurdistan were almost at the gates of Ispahan; the Abdallee Afghans had taken Herat, and afterwards Mushed; the islands in the Persian Gulf had been subdued by the Arabian governor of Mascat; and the rude tribes of Georgia had attacked Shirwan, and plundered Shamachie. A prediction by an astrologer, of the total destruction of the capital by an earthquake, completed the public dismay, when intelligence was received that Mahmoud Ghiljee had entered the country at the head of 25,000 Afghans. He was met by the royal army of 50,000 troops; and an action took place, which ended entirely in favour of the Afghans. The consequence was the siege or blockade of Ispahan, which, after enduring all the miseries of famine, surrendered on the 21st of October, after a siege of seven months. The following day the fallen monarch of Persia, Hussein, took a solemn leave of his subjects, and signed a capitulation, by which he resigned the crown to Mahmoud. He proceeded, attended by a train of nobles, and by 300 troops, towards the Afghan camp; and being permitted, after some delay, to proceed to the palace of Ferrahabad, he was introduced into a great hall or saloon, where he found the conqueror seated. He addressed him in the following words. "Son, since the great sovereign of the universe does not will that I should reign any longer, and the moment has come which he has appointed for thy ascending the throne of Persia, I resign the empire to thee. May thy reign be prosperous." He then presented the royal plume of feathers, which he took from his turban, to the vizier of Mahmoud; but that prince refusing to accept it from any other than the monarch to whom it belonged, the humbled prince now took it from the minister, and placed the emblem of royalty in the turban of his enemy, who all the while retained his seat, and exclaimed, "Reign in peace." After the usual refreshments of tea and coffee, Mahmoud addressed his captive. "Such," said he, "is the instability of human grandeur. God disposes of empires as he pleases; he takes them from one to give to another; but I promise ever to consider you as my father, and to undertake nothing without your advice."[1] Hussein, with his nobles, after doing homage to the Afghan sovereign, was confined for seven years in a small palace, when his enemies, threatened with a reverse of fortune, caused him to be assassinated; and in his person may be said to have terminated the Suffavean dynasty, as his son Tamasp, though he assumed the title of king, never possessed any real power, and only struggled a few years against his inevitable fate.

Mahmoud having thus succeeded in acquiring the sovereignty of Persia, now endeavoured to conciliate the people whom he had subdued. But the Persians hated the Afghan yoke; and, as they recovered from their first dismay, they began to attack and to cut off scattered parties of the invaders. At the same time Persia was invaded both by Russian and Turkish armies. The Russian army advanced into the country and took possession of Derbend, and the Turkish army was already on its march to Hamadan, when the inhabitants of Kazreen rose in insurrection, and expelled the Afghan garrison from the place. Mahmoud was now seriously alarmed. The probable revolt of the capital seemed to be the most immediate danger; and his gloomy mind, alarmed and enraged by these signs of vengeance, conceived the horrible design of exterminating the conquered people. He commenced with the massacre of three hundred nobles and their children, who were treacherously invited to a feast. He afterwards put to death three thousand of the late king's guards, whom he had taken into his pay; and at length every person who had

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[1] Sir John Malcolm's History of Persia, chap. xv. p. 343.

Persia. been in the service of Shah Hussein was included in one bloody proscription, and put to death without mercy. For fifteen days the city of Ispahan was one scene of blood, and the spirit of the people was so broken under this unheard of tyranny, that one Afghan might often be seen leading three or four Persians to execution.

After this, Mahmoud, being aided by the Kurdish tribes, succeeded in making himself master of some of the principal cities of Irak and Fars. But his affairs appeared to be on the decline; his kingdom was threatened from various points, and his mind proved at last unequal to the difficulties with which he was assailed. In this extremity he resorted for relief to the most abject and degrading superstitions; he shut himself up in a vault for fourteen days and nights, fasting and enduring the severest penances; and, under the influence of this gloomy fanaticism, he lost his reason, and fell into the most furious paroxysms of madness. In this melancholy situation his mother, out of compassion to him, directed him to be smothered. But this event did not take place till, under his fatal orders, thirty-nine princes of the Suffavean blood had suffered an untimely death. He was succeeded by Ashruff, the son of Meer Abdallah, and nephew of Meer Vais. The first period of Ashruff's reign was successful. He gained repeated victories over the Turkish armies, who were compelled to retire; and he concluded the war by compelling the Turkish court to acknowledge his title to the throne. But he was now assailed from another quarter by more serious dangers. Tamasp, the son of Shah Hussein, and the representative of the Suffavean princes, was in Mazanderan, where he was joined by a distinguished chief, Nadir Kouli, a well-known warrior, who now declared his resolution to expel every Afghan from the soil of Persia. Tamasp, from the day of his father's abdication, had assumed royal state, and, now that he was supported by Nadir and the nobles of Khorassan and Mazanderan, he found himself in a condition to exercise the authority of a sovereign. Nadir being invested with the sole command, soon succeeded in reducing Mushed and Herat, and at length all Khorassan, under the authority of Tamasp. Ashruff now prepared for the defence of his sovereign authority; and having raised an army, he advanced into Khorassan against his enemy, whose followers, he knew, were daily increasing. The Afghans
A. D. 1729. were defeated in a series of sanguinary actions, and pursued, first to Teheran, and finally to the gates of Ispahan. It was at first proclaimed in the city that the Afghans had obtained the victory; but the loud wailings of the women from the citadel soon disclosed the result of the battle. The night was passed in preparations for flight. The old men, women, and children, were mounted on mules and camels, and having packed up all the treasure and spoil which they could carry away, they took the route to Shiraz by break of day; the tyrant Ashruff having in the mean time cruelly murdered Shah Hussein, who was still detained a prisoner, and the pressure of circumstances only preventing a general massacre, which was fully intended. Nadir lost no time in pursuing the discouraged and flying Afghans. They were overtaken at Persepolis, and immediately fled towards Shiraz, where, though they were still 20,000 strong, they were deserted by their leader, who fled homewards with only two hundred followers. The army was dispersed in wandering bands, which were closely pursued and cut down by their exasperated foes; and Ashruff himself, whilst wandering in Seistan, was recognised and slain by Abdallah Khan, a soldier of Beloochistan, who sent his head, with a large diamond which he found on his person, to Shah Tamasp. The Afghan invasion was one of the most cruel calamities which ever befell the Persians. Within the short period of seven years they had massacred nearly a million of the inhabitants, laid waste the finest provinces of the country, and levelled the proudest edifices with the dust; yet they had neither the power nor the policy to maintain their conquest. From the first to the last day of their rule they appeared only a small body of foreigners in the midst of a great nation; and they accordingly fell before the first aspiring adventurer who could combine and direct the national resources against the ill-constructed fabric of their power. Persi

Nadir Shah was born in the province of Khorassan, on the 11th of November 1688. His father was in a low condition, earning a livelihood by making coats and caps of sheep-skins. He was taken prisoner by the Uzbecks at the age of seventeen, but made his escape from them after a captivity of four years. He was for a considerable period the chief of a band of robbers, the high way in those countries to distinction and power. He experienced many vicissitudes of fortune; and being a plunderer of known valour and resolution, he had collected 3000 followers, by whose aid he laid under contribution the extensive province of Khorassan. His friendship was now courted by A. D. 1
his uncle, who was in possession of the fort of Kelat. Nadir pretended to listen to his overtures; but deeming him an obstacle to his further rise, he treacherously slew him with his own hands, and proceeded to employ the power which he had thus acquired against the Afghans, the enemies of his country. And so well did he succeed in this popular and patriotic enterprise, that the Afghans were entirely expelled from the country; whilst, for his eminent services, he received a gift from his sovereign, Tamasp, of the four provinces of Khorassan, Mazanderan, Seistan, and Kerman. He then proceeded to attack the Turks, who still occupied the western provinces of Irak and Azerbijan, and having defeated them in various actions, took possession of Tabriz, Ardebil, and all the principal cities. He returned to quell an alarming insurrection of the Afghans, who were unable to withstand his victorious armies; and in the mean time the imbecile Tamasp commenced a war with the Turks, which ended in a disgraceful peace. He had for some time been a mere pageant in the hands of Nadir; and this unfortunate war, with other complaints against him, furnished a plausible pretence for his dethronement, which took place on the 16th of August 1732. He retired to Khorassan, where he was afterwards put to death by Reza Kouli, the son of Nadir, and with the knowledge, if not by the secret orders, of the father. His son, an infant eight months old, was seated on the throne; but Nadir was now in substance, as he was soon to be in form, the real sovereign. In 1736 the death of this infant removed the only obstacle to his ambition; and, in a vast assembly of his nobles and troops, he was, after much pretended reluctance, prevailed on to accept of the crown. This high dignity served only to give a fresh stimulus to his active and enterprising habits. In the course of a new war with the Turks, having regained the provinces which had been wrested from the imbecile Tamasp, and concluded a peace, he turned his arms eastward. Candahar and Balkh were besieged and taken by his son Reza Kouli, who passed the Oxus, and defeated the ruler of Bukharia and the Uzbecks. Afghanistan was afterwards subdued; and Nadir finally completed his military glory by the conquest of Delhi. A single battle was sufficient to disperse the Mogul host; and Nadir, with his triumphant legions, entered the capital, which made no resistance. Its treasures were plundered; and its inhabitants, who rose on the Persian soldiery, were, in revenge, given over to an indiscriminate massacre, in which neither age nor sex was spared. Nadir returned in triumph, loaded A. D. 1
with the spoils of one of the richest capitals of the East. He continued to prosecute his conquests on every side, and restored the ancient glory of the Persian empire, when it extended from the chain of the Caucasus eastward to the Indus.

But the glory of foreign conquest was tarnished by domestic tyranny. In an expedition against the Lesghees, a mountain tribe upon the western frontier, Nadir was wounded by an assassin, who fired on him from a wood. His suspicion fell on his son Reza Kouli, or had been instilled into his mind by artful intriguers. Under this impression he commanded his son into his presence, and immediately caused him to be deprived of his eyesight. But so struck was he with remorse after the deed had been done, that he vented his fury upon all around him; and fifty noblemen were put to death by his orders, because they had not come forward to sacrifice their lives for the young prince, the hope of his country. "It is not my eyes," says the prince, "that you have put out, but those of Persia." The mind of Nadir was deeply affected; he became gloomy and ferocious; all his future actions were deeds of horror; and he exceeded in barbarity all that has ever been recorded of the most bloody tyrants. The country languished under his extortions; and when he at last raised the people to insurrection, his fury knew no bounds, and he not only murdered individuals, but gave up whole cities to the destroying sword. Several of the principal officers of his court, learning that their names were in a proscribed list, resolved to anticipate the vengeance of the tyrant. The execution of the plot was committed to four chiefs who were employed about the palace, and who, on the pretext of business, rushed past the guards in the inner tents, and found the tyrant asleep. He was awakened by the noise, and had slain two of the conspirators, when he was deprived of life by a blow from Salah Beg, the captain of the guards.

The sudden death of Nadir Shah involved the country in the greatest distraction. He was succeeded by his nephew Ali, who took the name of Adil Shah. But his reign was short and inglorious. He was taken prisoner by his brother Ibrahim Khan, and put to death at Mushed, as his captor himself also was, being slain by the officer who guarded him. Shah Rokh, the grandson of Nadir, succeeded; but the throne was ere long usurped by Meerza Syud Mahommed, by whom Shah Rokh was taken prisoner and deprived of sight. The usurper being defeated and taken prisoner by Yusuf Ali, the principal general of Shah Rokh's army, was immediately put to death. The blind Shah Rokh was again raised to the throne; but the measures of his general, Yusuf Ali, were opposed by two chiefs, the respective heads of a Kurdish and an Arabian tribe, and by their joint efforts the faithful general of Shah Rokh was defeated and slain, and he himself again sent from a throne to a prison. The two chiefs, however, soon quarrelled; and Meer Aulum, the Arabian, triumphed, but only to fall before the rising power of the Afghans under Ahmed Khan Abdallee. This leader might at the time have easily accomplished the reduction of Persia. But judging more wisely, he assembled the principal chiefs, and proposed to them that the province which gave birth to Nadir should be given as a principality to his grandson. To this all the chiefs agreed, and Shah Rokh was again established in the undisturbed possession of Khorassan. At this period Persia was in a complete state of distraction, from the contentions of rival chiefs. Mahommed Hussein Khan, chief of the tribe of Kujurs, had established himself at Astrabad, and had brought under his authority the whole province of Mazanderan. The province of Azerbijan was under the rule of Azad Khan, an Afghan leader, who had been one of the generals of Nadir Shah. Gheelan was independent, under one of its own chiefs, Hidayet Khan. At this time Ali Murdan Khan, a chief of the tribe Bukteearee, took possession of Ispahan, and, resolving to elevate a prince of the house of Suffee to the throne, he invited the nobles to join his standard. The principal of those chiefs was Kurreen Khan, of the tribe of Zund, a man distinguished by his sagacity and courage, and between whom and Ali Murdan Khan a rivalship for power soon took place. Kurreen Khan, dreading the enmity of Ali Murdan, took the field against him. But his assassination soon afterwards left Kurreen undisputed master of the south of Persia. He was joined by most of the tribes from that country, and being at war with Azad Khan, he was entirely defeated by him in a general action, and so discouraged by the unpromising state of his affairs, that he meditated a retreat into India. But he was dissuaded from so unworthy a course by the remonstrances of his general Roostum Sultan, the chief of Khisht, who attacked the enemy in a narrow pass, and obtaining a complete victory, re-established the power of Kurreen Khan, who again occupied the city of Shiraz, where he employed his utmost efforts to recruit his army. Azad Khan, throwing himself on the clemency of his conqueror, was received into his service, and became one of his most attached followers. The most powerful enemy of Kurreen Khan was Mahommed Hussein Khan, the chief of the Kujurs, who ruled in Mazanderan. He advanced against Shiraz with a powerful force; but the city being bravely defended, he was compelled to raise the siege, and to retreat to Ispahan. He afterwards engaged Kurreen in a general action, in which, being deserted by part of his troops, he was defeated and slain. The whole province of Mazanderan then submitted to the conqueror, and this was followed by the submission of Gheelan and the greater part of Azerbijan. Khorassan was the only province which he did not subdue; and his forbearance is ascribed to compassion for the blind Shah Rokh, who still retained this remnant of his extensive dominions.

Kurreen Khan was distinguished by a love of justice and a moderation not usual amongst eastern princes. He died in the year 1779, in the eightieth year of his age, after a reign of twenty-six years. His administration was generally just and beneficent. He encouraged agriculture and commerce, which greatly revived during the latter years of his reign; and he protected, by his justice, Christians as well as Mahommedans. He never refused mercy to a fallen foe, though he sometimes punished severely, that he might strike terror into his enemies. Many stories are recorded of him, which display the kindness of his heart. He often repeated an anecdote of his early life. "When I was a poor soldier," said Kurreen, "in Nadir Shah's camp, my necessity led me to steal from a saddler a gold-embossed saddle, which had been sent by an Afghan chief to be repaired. I soon afterwards learned, that the man from whose shop it had been taken was lying in prison under sentence of death. My conscience smote me, and I replaced the saddle exactly on the place whence I took it. I watched till it was discovered by the saddler's wife, who on seeing it gave a scream of joy, fell down upon her knees, and prayed aloud that the person who had brought it back might live to have a hundred gold-embossed saddles. I am quite certain," he added, smiling, "that the honest prayer of the old woman has aided my fortune in the attainment of that splendour which she desired I should enjoy."[1] The humane disposition of this prince prompted him to acts of mercy; and the generous confidence with which he treated those whom he forgave, never failed to attach them to his person. It is the practice of the Persian kings to devote a portion of their time to hear the complaints of their subjects; and the following anecdote related of Kurreen Khan illustrates the temper and consideration with which he performed this important duty.

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[1] Sir John Malcolm's History of Persia, chap. xviii.

He was one day on the point of retiring from the judgment-seat, harassed and fatigued with a long attendance, when a suitor rushed forward in the greatest distraction, and, calling aloud for justice, complained that he had been robbed and plundered by thieves of all he possessed. “What was you about,” said the prince, “when you was robbed?” “I was asleep,” answered the man. “And why did you sleep?” exclaimed Kurreen, in an impatient tone. “Because,” said the suitor, “I made a mistake, and thought you was awake.” The royal judge, pleased with this manly boldness, turned to his vizier, and desired him to pay the merchant's losses from the treasury. “We must,” he added, “try to recover the property from the robbers.”

After the death of Kurreen Khan, the succession to the crown was, as usual, disputed, and in the course of these contests his four sons either perished under the daggers of assassins, or were sacrificed in the intrigues of ambitious chiefs contending for the crown. Zuckee Khan, the moment his father died, assumed the reins of government; whilst Saaduck Khan at the same time evacuated Bassorah, and advanced towards Shiraz. But he was unable to contend against Zuckee Khan, and was soon forced to retire. In the mean time, Aga Mahommed Khan Kujur, who had been detained prisoner at Shiraz, and who was duly apprized by his sister, an inmate of the royal harem, of the progress of Kurreen Khan's illness, and at last of his death, contrived to escape to Mazanderan, where he proclaimed himself a competitor for the throne. The cruelties of Zuckee, who had treacherously murdered a number of his rebellious nobles, after pledging his faith for their safety, soon provoked revenge, and he was himself put to death at Yezdikhanst. Aboul Futteh Khan was proclaimed king of Persia the moment Zuckee Khan was put to death. Saaduck Khan hastened from Kerman to Shiraz when he heard of the assassination of Zuckee Khan, and proclaimed himself king, arresting the person of Aboul Futteh Khan, and causing his eyes to be put out. He was besieged in his capital by his nephew Ali Mourad Khan, his most formidable enemy, and, being obliged to surrender, he was put to death, with most of his sons. Ali Mourad was, in his turn, put down by another rival; and Jaffier Khan, nephew of Kurreen, and Aga Mahommed, were at length the only rivals left to contend for the crown. The former having disgusted one of his chief supporters, Hajee Ali Kouli, he engaged in a conspiracy against him; and having put poison in his victuals, he and others rushed into his chamber when he was writhing under its effects, and put a period to his existence. He was succeeded by Lootf Ali Khan, who was one of the most remarkable characters recorded in the Persian annals. His appearance was greatly in his favour; his fine countenance, full of animated expression; his form tall and graceful, and, though slender, active and strong. He was at Kerman when he heard of his father's murder, which took place in the year 1789; and though Syud Mourad Khan was at first proclaimed king by the conspirators, yet, by the aid of Hajee Ibrahim, appointed by his father the first magistrate of the province of Fars, he was soon enabled to assert his claim to the crown. He was bold in counsel and fearless in action, and maintained a long and well-sustained struggle for the sovereignty, in the course of which he performed prodigies of valour. But he wanted prudence and temper, and had no control over his passions. Unbending in his pride, and harsh and unconciliating in his manners, he employed terror as the chief source of his influence. His great error was in quarrelling with and disgusting his faithful minister Hajee Ibrahim, a statesman of consummate prudence and talents, who abandoned his service for that of his rival and enemy, Aga Mahommed Khan, and was ever afterwards his most formidable enemy.[1] Lootf Ali maintained the contest for six years; the “slightest spark,” according to a Persian author, “always rekindling the flame of hope in the breast of the warrior.” But he was at length overwhelmed by the superior forces of his enemy; and, flying from Persia, he was treacherously seized, after a brave resistance, in which he was seriously wounded, and being delivered into the hands of Aga Mahommed Khan, was treated with a brutality of insult which is too shocking to be described, and which, Sir John Malcolm adds, disgraced human nature. His eyes were torn out, and he was sent to languish out a miserable existence in Teheran, where an order was soon afterwards sent for his execution. Lootf Ali terminated his extraordinary career in 1795, in the twenty-fifth year of his age. Nor was Aga Mahommed's cruel treatment of the inhabitants of Kerman less shocking. This place was the last stronghold of Lootf Ali. It was defended by him with his usual bravery, and being at length taken by treachery, became the scene of the most dreadful atrocities. The place was almost depopulated. Many women and children, to the number of 20,000, were carried into slavery. The men were murdered, and numbers were deprived of sight, many of whom were afterwards seen by Sir John Malcolm begging their bread. Lootf Ali was the last of the Zund family of princes, who had ruled over Persia for nearly half a century.

Aga Mahommed Khan having now firmly established himself upon the throne of Persia, his first care was to restore order throughout his dominions, and to repel foreign aggression. Having tranquillized the southern and central provinces, he invaded Armenia and Karabang, and marching straight to Teflis, he defeated Heraclius, prince of Georgia; and having taken the city, he sacked it, and made a dreadful slaughter of the inhabitants, carrying into slavery 20,000 women and children. He then turned his arms eastward, subdued Khorassan, and repressed the incursions of the pillaging Turcomans in the vicinity of Astrabad, as well as of the Uzbecks in Bukharia. But however rigorous his administration, and however active in the field, all his exploits were stained with cruelties. His avarice was unbounded; and he scrupled at no atrocity to gratify it. He had long thirsted after the jewels of which Nadir Shah had despoiled India, and these he wrested without remorse from their unfortunate possessors. From the aged and blind Shah Rokh he extorted, by the severest tortures, several of those which were the most precious, particularly a ruby, which had belonged to Aurungzebe, and which was of extraordinary size and value. This precious jewel was retained to the last, until boiling lead had been poured upon the head of the unhappy prince, when, in his intolerable agony, he declared where it was hidden. He was afterwards conveyed to Damghan in Khorassan, where he died in a few days, in the sixty-third year of his age, in consequence of the tortures to which he had been subjected.

Aga Mahommed Khan succeeded in tranquillizing the country, partly by policy, and still more by terror. He often spared his enemies, and conciliated them, not however from any feeling of humanity, but from a sense of his own interest; for his disposition was stern, cruel, and vindictive, and his reign presents a series of atrocities scarcely equalled in the bloody annals of the East. Sir John Malcolm palliates his atrocities, and observes, that though his executions are murders, we must not assume that justice is always violated, because the form of administering it is repugnant to our feelings; and, further, he adds, that "the punishment of bodies of men to deter others of similar condition from equal guilt, is perhaps the only mode by which uncivilized nations can be preserved in peace."[1] But according to Sir John Malcolm's own account, not only the forms, but every principle of justice, were violated by the executions, or murders, as he justly calls them, of the Persian despot. Ali Khan, a chief of the Affshar tribe, had opposed Aga Mahommed Khan in the field. He was decoyed into his power by the deepest treachery, and being arrested amidst fawning and caresses, his eyes were put out. The brave and generous Jaffier Kouli, his own brother, was in like manner seduced, by the kindest assurances, to visit the court at Teheran, where he was welcomed with every appearance of cordiality, and the night passed in peace. Next day Aga Mahommed observed, "You have not, I believe, looked at the new palace; walk there with Baba Khan (his son), and after you have seen it, return to me." But the moment he entered the portico, some assassins who had been stationed there fell upon him and slew him. This act, unequalled in atrocity, stamps upon Aga Mahommed the character of a cold-blooded villain, whose portrait may be truly drawn in the words of the immortal poet, "I can smile, and smile, and murder when I smile." And were not justice and humanity alike violated in the cruel torture of the blind Shah Rokh? The punishment of bodies of men, that is, the indiscriminate massacre of thousands, including infants and old men, and the carrying off of women by violence, Sir John Malcolm palliates on the tyrant's plea, necessity; as if cruelty, and not justice and humanity, were the only mode of maintaining peace amongst uncivilized nations, or as if it were quite allowable in political morality to kill one half of a nation in order to compel the other to abandon their barbarous mode of living. The truth is, that Aga Mahommed appears to have been a prodigy of cruelty, swayed alternately by avarice and revenge, and his own absolute will, the only warrant of his evil deeds; so that it is idle to try his conduct by any moral test. Many stories are related of his implacable cruelty and revenge. He not only murdered or deprived of sight all the relations of Lootf Ali, but he dug up the bones of the virtuous Kurreen Khan and those of Nadir Shah, which he caused to be burned at the entrance of his palace, that he might indulge in the savage pleasure of trampling on their remains. The following is a trait of his vindictive disposition. "I could not," he has been known to say, "express openly the hatred and revenge I harboured against the murderers of my father, and the despoilers of my inheritance; but whilst sitting with Kurreen Khan in his hall of audience, I often used to cut his fine carpets with a pen-knife concealed under my cloak, and felt some relief in doing him this secret injury. It was foolish, and betrayed a want of forecast; for these carpets are mine, and I might have even then calculated on their being so."

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[1] See, in Sir John Malcolm's excellent History of Persia, a full account of all the transactions of Lootf Ali's reign. Sir John was personally acquainted with Hajee Ibrahim, who informed him that his principal reason for taking part with Mahommed Khan was, to save his country from the continual petty wars with which it had been long afflicted. (Vol. ii. chap. xix. p. 183.)

Aga Mahommed Khan being apprised of the invasion of Persia by Russia, sent his army to defend the frontier. But the death of the Empress Catharine relieved Persia from the serious danger with which it was threatened. Aga Mahommed then determined to move towards Georgia; and having received a friendly deputation from the inhabitants of Sheshah, he proceeded with some light troops, and took possession of this important fortress. Three days afterwards, a dispute having occurred between a Georgian slave, a personal attendant on the monarch, and another servant, respecting some money that was missing, the king, enraged at the noise which they made, directed that they should both be put to death. Saaduck Khan Shekakee, a nobleman of the highest rank, solicited their pardon, which was refused; but as it was the night of Friday, sacred to prayer, their lives were spared till next morning, and, with a singular infatuation, the despot permitted them to perform their usual services about his person. Despair gave them courage; and whilst the monarch was asleep, they entered his tent, accompanied by an associate, and stabbed with their poniards one of the ablest monarchs (according to Sir John Malcolm) who ever sat on the throne of Persia. He was then in the sixty-third year of his age, and had ruled for upwards of twenty years, though he had enjoyed the undisputed sovereignty of the country for only a small portion of that time.

Aga Mahommed Khan was in person so slender, that he appeared like a youth of fourteen or fifteen. His face was beardless and shrivelled, resembling that of an aged and wrinkled woman; it was at no time pleasant or agreeable, and when clouded with indignation, as it often was, its expression was horrible. He was so sensible of this, that he could not bear any one to look at him. "The first passion of his mind," says Sir John Malcolm, "was the love of power, the second avarice, and the third revenge. In all these he indulged to excess. He was harsh and abrupt, and often cruel to his ministers and to his domestics, who trembled at the sound of his shrill and dissonant voice, which was generally raised to utter some term of gross abuse, or issue an order for punishment. The minister Hajee Ibrahim was, however, an exception. He was uniformly treated with unbounded confidence." "The penetration of the monarch," says the historian of Persia so often quoted, "discovered at once the talents of that extraordinary man, whose plainness of manner, blunt speech, manly fortitude, and astonishing knowledge of public affairs, led Aga Mahommed to give him his entire confidence, and no confidence was ever better rewarded. The minister, though he contrived to gratify the avarice of his master, and to promote his ambition, often obtained favour for others through the kindness of his disposition, whenever he could interfere without danger to himself. He was generally dressed in the plainest manner, and he greatly disliked the hyperbolical complimentary style of the East, insomuch that, when the secretaries of the court, in reading papers to him, commenced their flowery introductions, he desired them to 'pass over the nonsense, and proceed to the subject of the letter at once.'"

By the influence and wise management of Hajee Ibrahim, the crown was secured to the nephew of the deceased monarch, who assumed the sovereignty under the title of Futteh Ali Khan. Saaduck Khan made a feeble effort to oppose him, but was attacked and defeated. Two other attempts to usurp the crown, the one made by the king's brother Hussein Kooli Khan, and the other by Mahommed Khan, a prince of the Zund family, were subdued; and since this period the internal tranquillity of the country has not been disturbed. The most important events in the reign of Futteh Ali were connected with the wars which he entered into with Russia, and which generally proved unfavourable to Persia. In 1800 Georgia finally submitted to the dominion of Russia; and in 1803 Mingrelia was subdued. Gonjah was taken; and although the invaders were forced to raise the siege of Erivan, they overran Daghistan and Shirwan, and, in 1805, Karabang yielded to their victorious arms. The interference of Great Britain arrested the progress of Russian conquest; and Persia was saved from further inroads by the treaty of Goolistan, concluded in October 1813, which fixed the relative boundaries so indefinitely, as, after much tedious negotiation, to give rise to a new war. In this war, which commenced in the month of July 1826, the prince royal of Persia took the field, with forty thousand men, twelve thousand of whom were regulars; and at the outset he gained several important advantages. But the superior discipline of the Russian armies, trained in the wars of Europe, triumphed in the end; and in 1828, seeing no prospect of maintaining the war with success, peace was again sought for through the mediation of Great Britain. It was concluded on the 21st of February, at Turkomanshee. Besides large cessions of territory, namely, the Khanat of Erivan and that of Nakshivan, and the greater part of Talish, including all the islands which fall within its direction, Persia agreed to pay ten crores, of 500,000 each, of tomauns, as an indemnification for the expenses of the war. Since this treaty, the peace of the two countries has not been disturbed; and the prince royal, turning his attention to the internal concerns of his kingdom, has succeeded in reducing the rebellious chiefs of Khorassan. By the aid of a Polish refugee, equally skilful and brave, he acquired possession of Yeza, took Toorshish and Khabooshan by storm, and reduced to obedience all the other chiefs in that quarter.

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[1] History of Persia, vol. ii. p. 272.

Still it is manifest, from the accounts of all travellers, that the present dynasty of the Kujurs stands upon a precarious foundation. The misrule which pervades every district of the country, the tyranny and extortions which oppress all classes, and the insecurity of life and property, have excited throughout the kingdom a thorough detestation of the present rulers. The people sigh for that security, that religious liberty, and that protection, which they know to be enjoyed under the British government in India; and it is well known that petitions have been addressed to influential quarters from a great proportion of the chiefs and nobles, and from other classes, craving permission to throw themselves on the protection of Britain, and declaring that if they are disappointed, they will solicit the aid of Russia. Any government, even that of foreigners, which would give them security for their lives and properties, they consider as preferable to the hated yoke of the Kujur tyrant. (F.)

PERSICUS Sinus, in *Ancient Geography*, a part of the sea which the Romans called *Mare Rubrum*, and the Greeks *Mare Erythræum*. On the east it is bounded by Arabia Felix, between which and Caramania it runs into the land, and washes Persia on the south.

PERSIUS Flaccus (Aulus), a celebrated Roman satirist, was a native of Volaterra in Etruria, and descended of an equestrian family of considerable eminence in the state. The little that we know respecting his personal history is chiefly derived from a slight sketch commonly ascribed to the pen of Suetonius. He was born A. D. 34, in the twentieth year of the reign of Tiberius, and died A. D. 62, in the twenty-eighth year of his age, and in the eighth of the reign of Nero. He lost his father at an early age; and his mother, Fulvia Sisennia, removed to Rome, that her son might enjoy the best education which the imperial city could furnish. He studied first under the grammarian Rhemmius Palæmon, and the rhetorician Virginius Flavus; and when he reached his sixteenth year, he was placed under the Stoic philosopher Annæus Cornutus, to whom he became passionately attached, and from whom he imbibed those tenets by which his writings are characterized. In his younger days he was much in the company of Pætus Thrasea, whose noble character must no doubt have tended to form the mind of Persius to virtuous habits. He was also intimately acquainted with Lucan, who had been his fellow-pupil under Cornutus. His admiration of the Satires of Lucilius is said to have first turned his attention to the study of poetry. His character was austere, his mode of life pure and blameless, and his affection for his friends strong and unbending. He left a considerable property to his mother and sisters; and his books, which are said to have consisted of seven hundred volumes, he bequeathed to his friend Cornutus. The philosopher recommended to his mother that she should commit to the flames all his manuscripts except his Satires. These were accordingly preserved, and consist of one book, divided, according to some, into five satires, and according to others, into six.

If we consider the nature and general scope of the writings of Persius, we shall find the severe tenets of the Stoics everywhere pervading them, and that the poet, unable to conceal the virtuous indignation which naturally rises in his breast, in contemplating the ignoble and vicious lives of those by whom he was surrounded, pours forth in strong and unmeasured language the feelings which occupy his soul. He disdains, like Horace, to laugh at those vices which he regards with such deep-felt abhorrence. He has none of the lively and playful humour of Horace; and there is a sternness and an austerity in his remarks, which leave a painful impression on the mind. He shows that he is entirely occupied with his subject, and that his sentiments flow from a mind deeply convinced of their truth. His language, however, is at times so obscure and enigmatical, that it is difficult to attach a meaning to it, even with the assistance of the ancient scholia. This circumstance has tended to detract much from the merits of Persius; but Quintilian and Martial, amongst the ancients, have both expressed a high admiration of his talents and writings.

The best edition of his Satires is that of Ruperti, published along with the Satires of Juvenal, Leipzig, 1819. The best separate edition is that of Franz Passow, with a metrical translation and introduction to the life and writings of Persius, Leipzig, 1809.

PERSON, an individual of a rational and intelligent nature. Thus we say, an ambassador represents the person of his prince; and that, in law, the father and son are reputed the same person.

Person, in *Grammar*, a term applied to such nouns or pronouns as, being either prefixed or understood, are the nominatives in all inflections of a verb. See Grammar.

PERSONAL, any thing that concerns, or is restricted to, the person.

Personal Action, in *Law*, is an action levied directly and solely against the person, in opposition to a real or a mixed action.

Personal Verb, in *Grammar*, a verb conjugated in all the three persons, and so called in opposition to an impersonal verb, or that which has the third person only.

PERSONALITY, in the schools, is that which constitutes an individual a distinct person.

PERSONIFYING, the assigning to an inanimate object the sentiments and language of a living being.

PERSPECTIVE.

Perspective is the art of drawing upon a plane surface true resemblances or pictures of objects, as the objects themselves appear to the eye from any distance and situation, real or imaginary.

It was in the sixteenth century that perspective was revived, or rather re-invented. It owes its birth to painting, and particularly to that branch of it which was employed in the decorations of the theatre, where landscapes were properly introduced, and which would have looked unnatural and horrid if the size of the objects had not been pretty nearly proportioned to their distance from the eye. We learn from Vitruvius, that Agatharchus, instructed by Æschylus, was the first who wrote upon this subject; and that afterwards the principles of the art were more distinctly taught by Democritus and Anaxagoras, the disciples of Agatharchus. Of the theory of this art, as described by them, we know nothing, since none of their writings have escaped the general wreck that was made of ancient literature in the dark ages of Europe. However, the revival of painting in Italy was accompanied with a revival of this art.

The first person who attempted to lay down the rules of perspective was Pietro del Borgo, an Italian. He supposed objects to be placed beyond a transparent tablet, and endeavoured to trace the images which rays of light emitted from them would make upon it. But we do not know what success he had in this attempt, because the book which he wrote upon the subject is not now extant. It was, however, very much commended by the famous Egnazio Dante; and, upon the principles of Borgo, Albert Durer constructed a machine, by which he could trace the perspective appearance of objects.

Balthazar Perussi studied the writings of Borgo, and endeavoured to render them more intelligible. To him we owe the discovery of points of distance, to which all lines that make an angle of forty-five degrees with the ground line are drawn. A little time after, Guido Ubaldi, another Italian, found that all the lines that are parallel to one another, if they be inclined to the ground line, converge to some point in the horizontal line; and that through this point also, a line drawn from the eye, parallel to them, will pass. These principles, put together, enabled him to make out a pretty complete theory of perspective.

Great improvements were made in the rules of perspective by subsequent geometricians; particularly by Professor Gravesande, and still more by Dr Brooke Taylor, whose principles are in a great measure new, and far more general than any that had been made before his time.

In order to understand the principles of perspective, it will be proper to consider the plane on which the representation is to be made as transparent, and interposed between the eye of the spectator and the object to be represented. Thus, suppose a person at a window looks through an upright pane of glass at any object beyond it, and, keeping his head steady, draws the figure of the object upon the glass with a black-lead pencil, as if the point of the pencil touched the object itself; he would then have a true representation of the object in perspective, as it appears to his eye.

In order to this, two things are necessary; first, that the glass be laid over with strong gum-water, which, when dry, will be fit for drawing upon, and will retain the traces of the pencil; and, secondly, that he look through a small hole in a thin plate of metal, fixed about a foot from the glass, between it and his eye, and that he keep his eye close to the hole, otherwise he might shift the position of his head, and consequently make a false delineation of the object.

Having traced the figure or outline of the object, he may go over it again with pen and ink, and when the ink is dry, put a sheet of paper upon it, and trace it thereon with a pencil; then taking away the paper and laying it upon a table, he may finish the picture by giving it the colours, lights, and shades, as he sees them in the object itself. By these means he will have a true resemblance of the object.

To every person who has a general knowledge of the principles of optics, this must be self-evident. For, as vision is occasioned by pencils of rays coming in straight lines to the eye from every point of the visible object, it is plain that, by joining the points in the transparent plane, through which all those pencils respectively pass, an exact representation must be formed of the object, as it appears to the eye in that particular position, and at that determined distance; and were pictures of things to be always first drawn on transparent planes, this simple operation, with the principle upon which it is founded, would comprehend the whole theory and practice of perspective. As this, however, is far from being the case, rules must be deduced from the sciences of optics and geometry, for drawing representations of visible objects upon opaque planes; and the application of these rules constitutes what is properly called the *art of perspective.*

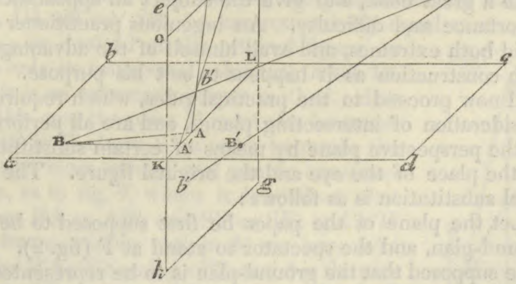
Previously to our laying down the fundamental principles of this art, it may not be improper to observe, that when a person stands right against the middle of one end of a long avenue or walk, which is straight and equally broad throughout, the sides thereof appear to approach nearer and nearer to each other as they are further and further from his eye; or the angles under which their different parts are seen become less and less according as the distance from his eye increases; and if the avenue be very long, the sides of it at the farthest end will seem to meet, and there an object that would cover the whole breadth of the avenue, and be of a height equal to that breadth, would appear to be only a mere point.

Having made these preliminary observations, we shall now proceed to the practice of perspective, which is built upon the following

THEOREM I.

Let *abcd* (fig. 1) represent the ground plan of the figure to be thrown into perspective, and *efgh* the transparent plane through which it is viewed by the eye at E. Let these planes intersect in the straight line KL. Let B be any

Fig. 1.



point in the ground-plan, and BE a straight line, the path of a ray of light from that point to the eye. This will pass through the plane *efgh* in some point *b*; or B will be seen through that point, and *b* will be the picture, image, or representation of B.

If BA be drawn in the ground-plan, making any angle BAK with the common intersection, and EV be drawn parallel to it, meeting the picture-plane or perspective plane in V, and VA be drawn, the point *b* is in the line VA so situated that BA is to EV as *b*A to *b*V.

For since EV and BA are parallel, the figure BA*b*VE*b*B is in one plane, cutting the perspective plane in the straight line VA; the triangles BA*b*, EV*b*, are similar, and BA : EV = *b*A : *b*V.

Cor. 1. If B be beyond the picture, its picture *b* is above the intersection KL; but if B be between the eye and the picture, as at B′, its picture *b*′ is below KL.

2. If two other parallel lines BA′, ES, be drawn, and A′, S, be joined, the picture of B is in the intersection of the lines AV and A′S.

3. The line BA is represented by *b*A, or *b*A is the picture of BA; and if AB be infinitely extended, it will be represented by AV. V is therefore called the *vanishing point* of the line AB.

4. All lines parallel to AB are represented by lines converging to V from the points where these lines intersect the perspective-plane; and therefore V is the vanishing point of all such parallel lines.

5. The pictures of all lines parallel to the perspective-plane are parallel to the lines themselves (fig. 8).

6. If through V (fig. 1) be drawn HVO parallel to KL, the angle EVH is equal to BAK.

Remark. The proposition now demonstrated is not limited to any inclination of the picture-plane to the ground-plane; but it is usual to consider them as perpendicular to each other, and the ground-plane as horizontal. Hence the line KL is called the *ground-line*, and OH the *horizon-line*; and OK, perpendicular to both, is called the *height of the eye.*

If ES be drawn perpendicular to the picture-plane, it will cut it in a point S of the horizon-line directly opposite to the eye. This is called the *point of sight*, or *principal point.*

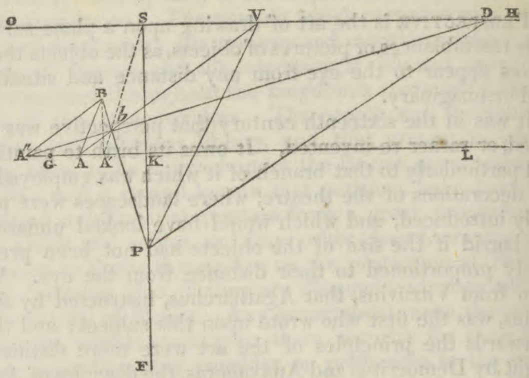
7. The pictures of all vertical lines are vertical, and the pictures of horizontal lines are horizontal, because these lines are parallel to the perspective plane.

8. The point of sight S is the vanishing point of all lines perpendicular to the perspective plane.

The above proposition is a sufficient foundation for the whole practice of perspective, whether on direct or inclined pictures, and serves to suggest all the various practical constructions, each of which has advantages which suit particular purposes. Writers on the subject have either confined themselves to one construction, from an affectation of simplicity or fondness for system; or have multiplied precepts, by giving every construction for every example, in order to make a great book, and give the subject an appearance of importance and difficulty. An ingenious practitioner will avoid both extremes, and avail himself of the advantage of each construction as it happens to suit his purpose. We shall now proceed to the practical rules, which require no consideration of intersecting planes, and are all performed on the perspective plane by means of certain substitutions for the place of the eye and the original figure. The general substitution is as follows:

Let the plane of the paper be first supposed to be the ground-plan, and the spectator to stand at F (fig. 2). Let it be supposed that the ground-plan is to be represented on a plane surface, standing perpendicularly on the line GKL of the plan, and that the point K is immediately opposite to the spectator, or that FK is perpendicular to GL: then FK is equal to the distance of the spectator's eye from the picture.

Fig 2.



Now suppose a piece of paper laid on the plan with its straight edge lying on the line GL; draw on this paper KS perpendicular to GL, and make it equal to the height of the eye above the ground-plan. This may be much greater than the height of a man, because the spectator may be standing on a place much raised above the ground-plan. Observe also that KS must be measured on the same scale on which the ground-plan and the distance FK were measured. Then draw HSO parallel to GL. This will be a horizontal line, and (when the picture is set upright on GL) will be on a level with the spectator's eye, and the point S will be directly opposite to his eye. It is therefore called the *principal point*, or *point of sight.* The distance of his eye from this point will be equal to FK. Therefore make SP (in the line SK) equal to FK, and P is the projecting point or substitute for the place of the eye. It is sometimes convenient to place P above S, sometimes to one side of it on the horizontal line, and in various other situations; and writers ignorant of, or inattentive to, the principles of the theory, have given it different denominations, such as *point of distance, point of view,* &c. It is merely a substitute for the point F in fig. 1, and its most natural situation is below, as in this figure.

The art of perspective is conveniently divided into Ichnography, which teaches how to make a perspective draught of figures on a plane, commonly called the ground-plan; and Scenography, which teaches how to draw solid figures, or such figures as are raised above this plan.

Prob. 1. *To put into perspective any given point of the ground-plan.*

First general construction.

From B and P (fig. 2) draw any two parallel lines BA, PV, cutting the ground-line and horizon-line in A and V, and draw BP, AV, cutting each other in *b*; *b* is the picture of B.

For it is evident that BA, PV of this figure are analogous to BA and EV of fig. 1, and that BA : PV = *b*A : *b*V.

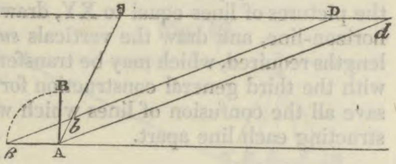
If BA′ be drawn perpendicular to GL, PV will fall on PS, and need not be drawn. A′V will be A′S. This is the most easy construction, and nearly the same with Ferguson's.

Second general construction.

Draw two lines BA, BA″, and two lines PV, PD, parallel to them, and draw AV, A″D, cutting each other in *b*; *b* is the picture of B by Cor. 2. This construction is the foundation of all the rules of perspective that are to be found in the books on this subject. They appear in a variety of forms, owing to the ignorance or inattention of the authors to the principles. The rule most generally adhered to is as follows;

Draw BA perpendicular to the ground-line, and AS to the point of sight, and set off $A\beta$ equal to BA. Set off SD equal to the distance of the eye in the opposite direction from S that β is from A, where B and E of fig. 1 are on opposite sides of the picture; otherwise set them the same way. D is called the point of distance. Draw βD, cutting AS in b. This is evidently equivalent to drawing BA′ and PS perpendicular to the ground-line and horizon-line, and BA″ and PD (fig. 2) making an angle of 45° with these lines, with the additional puzzle about the way of setting off A′A″ and SD, which is avoided in the construction here given.

Fig. 3.



This usual construction, however, by a perpendicular and the point of distance, is extremely simple and convenient; and two points of distance, one on each side of S, serve for all points of the ground-plan. But the first general construction requires still fewer lines, if BA be drawn perpendicular to GL, because PV will then coincide with PS.

Third general construction.

Draw BA (fig. 3) from the given point B perpendicular to the ground-line, and AS to the point of sight. From the point of distance D set off Dd equal to BA, on the same or the contrary sides as S, according as B is on the same or the contrary side of the picture as the eye. Join d A, and draw Db parallel to dA. b is the picture of B. For SD, Dd are equal to the distances of the eye and given point from the picture, and SD : Dd = b S : bA.

This construction does not naturally arise from the original lines, but is a geometrical consequence from their position and magnitude; and it is of all others the most generally convenient, as the perpendicular distances of any number of points may be arranged along SD without confusion, and their direct situations transferred to the ground-line by perpendiculars such as BA; and nothing is easier than drawing parallels, either by a parallel ruler or a bevel square, used by all who practise drawing.

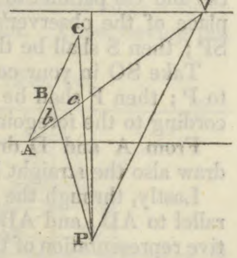
Prob. 2. *To put any straight line* BC *of the ground-plan in perspective.*

Find the pictures b, c, of its extreme points by any of the foregoing constructions, and join them by the straight line bc.

Perhaps the following construction will be found very generally convenient.

Produce CB till it meet the ground-line in A, and draw PV parallel to it; join AV, and draw PB, PC, cutting AV in b, c. V is its vanishing point, by Cor. 3 of the fundamental theorem.

Fig. 4.



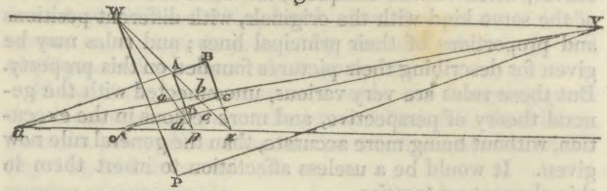
It must be left to the experience and sagacity of the drawer to select such circumstances as are most suitable to the multiplicity of the figures to be drawn.

Prob. 3. *To put any rectilineal figure of the ground-plan in perspective.*

Put the bounding lines in perspective, and the problem is solved.

The variety of constructions of this problem is very great, and it would fill a volume to give them all. The most generally convenient is to find the vanishing points of the bounding lines, and connect these with the points of their intersection with the ground line. For example, to put the square ABCD (fig. 5) into perspective.

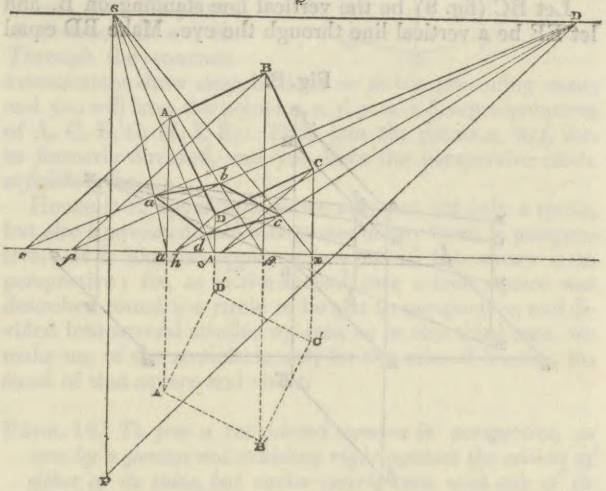
Fig. 5.



Draw from the projecting point PV, PW, parallel to AB, BC, and let AB, BC, CD, DA, meet the ground line in α, κ, δ, β, and draw αV, δV, κW, βW, cutting each other in $abcd$, the picture of the square ABCD. The demonstration is evident.

This construction, however, runs the figure to great distances on each side of the middle line, when any of the lines of the original figure are nearly parallel to the ground-line. The following construction avoids this inconvenience.

Fig. 6.

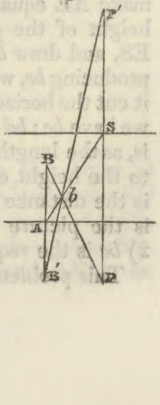


Let D be the point of distance. Draw the perpendiculars Aα, Bβ, Cκ, Dδ, and the lines Ae, Bf, Cg, Dh, parallel to PD. Draw Sα, Sβ, Sκ, Sδ, and De, Df, Dg, Dh, cutting the former in a, b, c, d, the angles of the picture.

It is not necessary that D be the point of distance; only the lines Ae, Bf, &c. must be parallel to PD.

Remark. In all the foregoing constructions the necessary lines (and even the finished picture) are frequently confounded with the original figure. To avoid this great inconvenience, the writers on perspective direct us to transpose the figure; that is, to transfer it to the other side of the ground-line, by producing the perpendiculars Aα, Bβ, Cκ, Dδ, till αA′ βB′, &c. are respectively equal to Aα, Bβ, &c.; or, instead of the original figure, to use only its transposed substitute A′B′C′D′. This is an extremely proper method. But in this case the point P must also be transposed to P′ above S, in order to retain the first or most natural and simple construction, as in fig. 7, where it is evident, that when BA = AB′, and SP = SP′, and B′P′ is drawn, cutting AS in b, we have bA : bS = B′A : P′S = BA : PS, and b is the picture of B; whence follows the truth of all the subsequent constructions with the transposed figure.

Fig. 7.



Prob. 4. *To put any curvilineal figure on the ground-plan into perspective.*

Put a sufficient number of its points in perspective by the foregoing rules, and draw a curve line through them.

It is well known that the conic sections and some other curves, when viewed obliquely, are conic sections or curves of the same kind with the originals, with different positions and proportions of their principal lines; and rules may be given for describing their pictures founded on this property. But these rules are very various, unconnected with the general theory of perspective, and more tedious in the execution, without being more accurate, than the general rule now given. It would be a useless affectation to insert them in this elementary treatise.

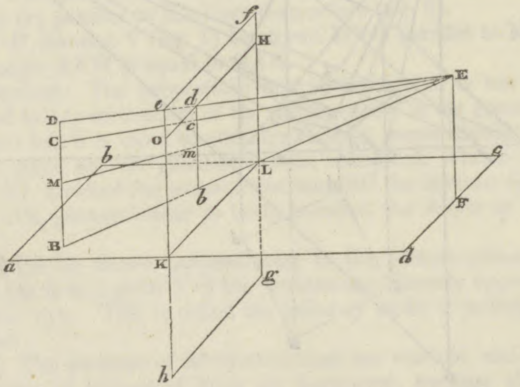
We come, in the next place, to the delineation of figures not in a horizontal plane, and of solid figures. For this purpose it is necessary to demonstrate the following

THEOREM II.

The length of any vertical line standing on the ground plane is to that of its picture as the height of the eye to the distance of the horizon-line from the picture of its foot.

Let BC (fig. 8) be the vertical line standing on B, and let EF be a vertical line through the eye. Make BD equal to EF, and draw DE, CE, BE. It is evident that DE will cut the horizon-line in some point *d*, CE will cut the picture-plane in *c*, and BE will cut it in *b*, and that *bc* will be the picture of BC, and is vertical, and that BC is to *bc* as BD to *bd*, or as EF to *bd*.

Fig. 8.

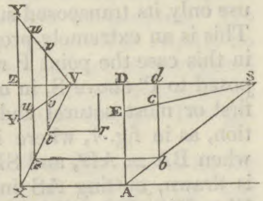


Cor. The picture of a vertical line is divided in the same ratio as the line itself. For BC : BM = *bc* : *bm*.

Prob. 5. *To put a vertical line of a given length in perspective standing on a given point of the picture.*

Through the given point *b* (fig. 9) of the picture draw S*b*A from the point of sight, and draw the vertical line AD, and make AE equal to the length or height of the given line. Join ES, and draw *bc* parallel to AD, producing *bc*, when necessary, till it cut the horizontal line in *d*, and we have *bc* : *bd* = AE : AD, that is, as the length of the given line to the height of the eye, and *bd* is the distance of the horizon-line from the point *b*, which is the picture of the foot of the line. Therefore (Theor. 2) *bc* is the required picture of the vertical line.

Fig. 9.



This problem occurs frequently in views of architecture; and a compendious method of solving it would be peculiarly convenient. For this purpose, draw a vertical line XZ at the margin of the picture, or on a separate paper, and through any point V of the horizon-line draw VX. Set off XY, the height of the vertical line, and draw VY. Then from any points *b*, *r*, on which it is required to have the pictures of lines equal to XY, draw *bs*, *rt*, parallel to the horizon-line, and draw the verticals *su*, *tv*: these have the lengths required, which may be transferred to *b* and *r*. This, with the third general construction for the base points, will save all the confusion of lines which would arise from constructing each line apart.

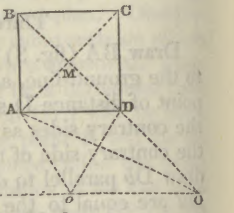
Prob. 6. *To put any sloping line in perspective.*

From the extremities of this line, suppose perpendiculars meeting the ground-plane in two points, which we shall call the base points of the sloping line. Put these base points in perspective, and draw, by last problem, the perpendiculars from the extremities. Join these by a straight line. It will be the picture required.

Prob. 7. *To put a square in perspective, as seen by a person not standing right against the middle of either of its sides, but rather nearly even with one of its corners.*

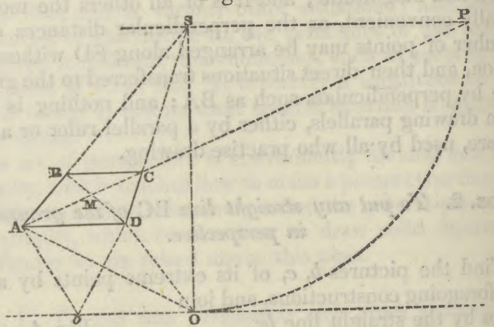
In fig. 10, let ABCD be a true square, viewed by an observer, not standing at *o*, directly against the middle of its sides AD, but at O almost even with its corner D, and viewing the side AD under the angle AOD; the angle A*o*D (under which he would have seen AD from *o*) being 60 degrees.

Fig. 10.



Make AD in fig. 11 equal to AD in fig. 10, and draw SP and O*o* parallel to AD. Then, in fig. 11, let O be the place of the observer's eye, and SO be perpendicular to SP; then S shall be the point of sight in the horizon SP.

Fig. 11.

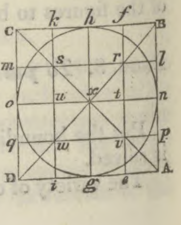


Take SO in your compasses, and set that extent from S to P; then P shall be the true point of distance, taken according to the foregoing rules.

From A and D draw the straight lines AS and DS; draw also the straight line AP, intersecting DS in C.

Lastly, through the point of intersection C draw BC parallel to AD; and ABCD in fig. 11 will be a true perspective representation of the square ABCD in fig. 10. The point M is the centre of each square, and AMC and BMD are the diagonals.

Fig. 12.



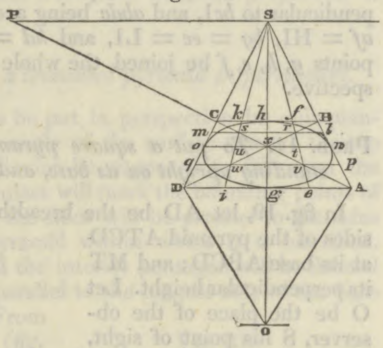
Prob. 8. *To put a reticulated square in perspective, as seen by a person standing opposite to the middle of one of its sides.*

A reticulated square is one that is divided into several little squares, like net-work, as fig. 12, each side of which is divided into four equal parts, and the whole surface into four times four (or sixteen) equal squares.

Having divided this square into the given number of lesser squares, draw the two diagonals AxC and BxD.

Make AD in fig. 13 equal to AD in fig. 12, and divide it into four equal parts, as Ae, eg, gi, and iD.

Fig. 13.



Draw SP for the horizon, parallel to AD, and, through the middle point g of AD, draw OS perpendicular to AD and SP. Make S the point of sight, and O the place of the observer's eye.

Take SP equal to SO, and P shall be the true point of distance. Draw AS and DS to the point of sight, and AP to the point of distance, intersecting DS in C: then draw BC parallel to AD, and the outlines of the reticulated square ABCD will be finished.

From the division points e, g, i, draw the straight lines ef, gh, ik, tending towards the point of sight S; and draw BD for one of the diagonals of the square, the other diagonal AC being already drawn.

Through the points r and s, where these diagonals cut ef and ik, draw lm parallel to AD. Through the centre point x, where the diagonals cut gh, draw no parallel to AD. Lastly, through the points v and w, where the diagonals cut ef and ik, draw pq parallel to AD; and the reticulated perspective square will be finished.

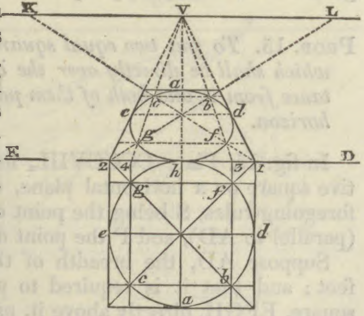
This square is truly represented, as if seen by an observer standing at O, and having his eye above the horizontal plane ABCD on which it is drawn, as if OS was the height of his eye above that plane; and the lines which form the small squares within it have the same letters of reference with those in fig. 12, which is drawn, as it would appear, to an eye placed perpendicularly above its centre x.

Prob. 9. *To put a circle in perspective.*

If a circle be viewed by an eye placed directly over its centre, it appears perfectly round; but if it be obliquely viewed, it appears of an elliptical shape. This is plain by looking at a common wine-glass set upright on a table.

Make a true reticulated square, as fig. 12, of the same diameter as you would have the circle; and setting one foot of your compasses in the centre x, describe as large a circle as the sides of the square will contain. Then, having put this reticulated square into perspective, as in fig. 13, observe through what points of the cross lines and diagonals of fig. 12 the circle passes; and through the like points in fig. 13 draw the ellipsis, which will be as true a perspective representation of the circle as the square in fig. 13 is of the square in fig. 12.

Fig. 14.

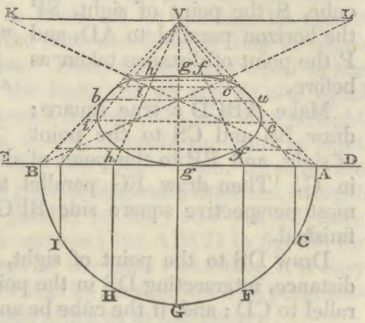


This is Mr Ferguson's rule for putting a circle in perspective; but the following rules by Wolf are perhaps more universal.

If the circle to be put in perspective be small, describe a square about it. Draw first the diagonals of the square, and then the diameters ha and de (fig. 14), cutting one another at right angles; draw the straight lines fg and bc parallel to the diameter de. Through b and f, and likewise c and g, draw straight lines meeting DE, the ground line of the picture, in the points 3 and 4. To the principal point V draw the straight lines 1V, 3V, 4V, 2V, and to the points of distance L and K, 2L and 1K. Lastly, join the points of intersection a, b, d, f, h, g, e, c, by the arcs ab, bd, df, and $abdfhgeca$ will be the circle in perspective.

If the circle be large, so as to make the foregoing practice inconvenient, bisect the ground line AB, describing, from the point of bisection as a centre, the semicircle AGB (fig. 15), and from any number of points in the circumference C, F, G, H, I, &c. draw to the ground line the perpendiculars C1, F2, G3, H4, I5, &c. From the points A, 1, 2, 3, 4, 5, B, draw straight lines to the principal point or point of sight V, likewise straight lines from B and A to the points of distance L and K. Through the common intersections draw straight lines as in the preceding case; and you will have the points a, c, f, g, h, i, b, representatives of A, C, F, G, H, I, B. Then join the points a, c, f, &c. as formerly directed, and you have the perspective circle $acfghibihgfca$.

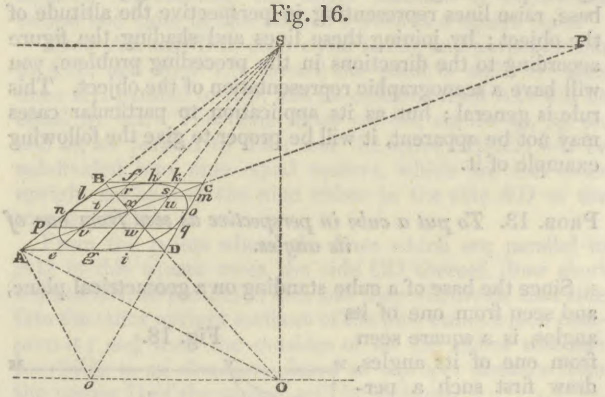
Fig. 15.



Hence it is apparent how we may put not only a circle, but also a pavement laid with stones of any form, in perspective. It is likewise apparent how useful the square is in perspective; for, as in the second case a true square was described round the circle to be put in perspective, and divided into several smaller squares, so in this third case, we make use of the semicircle only for the sake of brevity, instead of that square and circle.

Prob. 10. *To put a reticulated square in perspective, as seen by a person not standing right against the middle of either of its sides, but rather nearly even with one of its corners.*

Fig. 16.



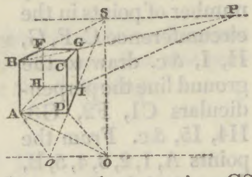
In fig. 16, let O be the place of an observer, viewing the square ABCD almost even with its corner D. Draw at pleasure SP for the horizon, parallel to AD, and make SO perpendicular to SP; then S shall be the point of sight, and P the true point of distance, if SP be made equal to SO.

Draw AS and DS to the point of sight, and AP to the point of distance, intersecting DS in the point C; then draw BC parallel to AD, and the outlines of the perspective square will be finished. This done, draw the lines which form the lesser squares, as taught in Prob. 8, and the work will be completed. You may put a perspective circle in this square by the same rule as it was done in fig. 13.

Prob. 11. *To put a cube in perspective, as if viewed by a person standing almost even with one of its edges, and seeing three of its sides.*

In fig. 17, let AB be the breadth of either of the six equal square sides of the cube AG; O the place of the observer, almost even with the edge CD of the cube, S the point of sight, SP the horizon parallel to AD, and P the point of distance taken as before.

Fig. 17.



Make ABCD a true square; draw BS and CS to the point of sight, and BP to the point of distance, intersecting CS in G. Then draw FG parallel to BC, and the uppermost perspective square side BFGC of the cube will be finished.

Draw DS to the point of sight, and AP to the point of distance, intersecting DS in the point I: then draw GI parallel to CD; and, if the cube be an opaque one, as of wood or metal, all the outlines of it will be finished; and then it may be shaded as in the figure.

But if you want a perspective view of a transparent glass cube, all the sides of which will be seen, draw AH toward the point of sight, FH parallel to BA, and HI parallel to AD: then AHID will be the square base of the cube, perspectively parallel to the top BFGC; ABFH will be the square side of the cube parallel to CGID, and FGIH will be the square side parallel to ABCD.

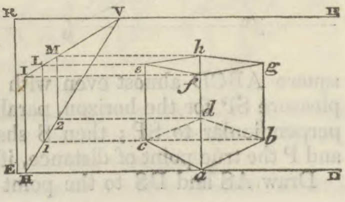
As to the shading part of the work, it is such mere children's play, in comparison of drawing the lines which form the shape of any object, that no rules need be given for it. Let a person sit with his left side toward a window, and he knows full well that if any solid body be placed on a table before him, the light will fall on the left-hand side of the body, and the right-hand side will be in the shade.

Prob. 12. *To put any solid in perspective.*

Put the base of the solid, whatever it be, in perspective by the preceding rules. From each bounding point of the base, raise lines representing in perspective the altitude of the object; by joining these lines and shading the figure according to the directions in the preceding problem, you will have a scenographic representation of the object. This rule is general; but as its application to particular cases may not be apparent, it will be proper to give the following example of it.

Prob. 13. *To put a cube in perspective as seen from one of its angles.*

Fig. 18.

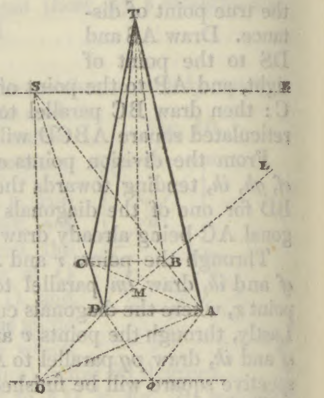


Since the base of a cube standing on a geometrical plane, and seen from one of its angles, is a square seen from one of its angles, draw first such a perspective square: then raise from any point of the ground-line DE (fig. 18) the perpendicular HI equal to the side of the square, and draw to any point V in the horizonal line HR the straight lines VI and VH. From the angles d, b, and c, draw the dotted lines $d2$ and $c1$ parallel to the ground line DE. Perpendicular to those dotted lines, and from the points 1 and 2, draw the straight lines L1 and M2. Lastly, since HI is the altitude of the intended cube in a, L1 in c and b, M2 in d, draw from the point a the straight line fa perpendicular to aE, and from the points b and c, bg and ce, perpendicular to $bc1$, and $abdc$ being according to rule, make $af = HI$, $bg = ec = L1$, and $hd = M2$. Then, if the points g, h, e, f be joined, the whole cube will be in perspective.

Prob. 14. *To put a square pyramid in perspective, as standing upright on its base, and viewed obliquely.*

In fig. 19, let AD be the breadth of either of the four sides of the pyramid ATCD at its base ABCD; and MT its perpendicular height. Let O be the place of the observer, S his point of sight, SE his horizon, parallel to AD and perpendicular to OS; and let the proper point of distance be taken in SE produced toward the left hand, as far from S as O is from S.

Fig. 19.



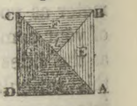
Draw AS and DS to the point of sight, and DL to the point of distance, intersecting AS in the point B. Then from B draw BC parallel to AD; and ABCD shall be the perspective square base of the pyramid.

Draw the diagonal AC, intersecting the other diagonal BD at M, and this point of intersection shall be the centre of the square base.

Draw MT perpendicular to AD, and of a length equal to the intended height of the pyramid: then draw the straight outlines AT, CT, and DT; and the outlines of the pyramid (as viewed from O) will be finished; which being done, the whole may be so shaded as to give it the appearance of a solid body.

If the observer had stood at o, he could have only seen the side ATD of the pyramid; and two is the greatest number of sides that he could see from any other place of the ground. But if he were at any height above the pyramid, and had his eye directly over its top, it would then appear as in fig. 20, and he would see all its four sides, E, F, G, H, with its top t just over the centre of its square base ABCD; which would be a true geometrical, and not a perspective square.

Fig. 20.



Prob. 15. *To put two equal squares in perspective, one of which shall be directly over the other, at any given distance from it, and both of them parallel to the plane of the horizon.*

In fig. 15, Plate CCCCVIII., let ABCD be a perspective square on a horizontal plane, drawn according to the foregoing rules, S being the point of sight, SP the horizon (parallel to AD), and P the point of distance.

Suppose AD, the breadth of this square, to be three feet; and that it is required to place just such another square, EFGH, directly above it, parallel to it, and two feet from it.

Make AE and DH perpendicular to AD, and two thirds of its length: draw EH, which will be equal and parallel

Perspective.

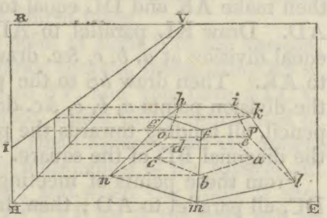
to AD; then draw ES and HS to the point of sight S, and EP to the point of distance P, intersecting HS in the point G: this done, draw FG parallel to EH; and you will have two perspective squares, ABCD and EFGH, equal and parallel to one another, the latter directly above the former, and two feet distant from it, as was required.

By this method shelves may be drawn parallel to one another, at any distance from each other in proportion to their length.

PROB. 16. *To put a truncated pyramid in perspective.*

Let the pyramid to be put in perspective be quinquangular. If from each angle of the surface whence the top is cut off, a perpendicular be supposed to fall upon the base, these perpendiculars will mark the bounding points of a pentagon, of which the sides will be parallel to the sides of the base of the pyramid within which it is inscribed. Join these points, and the interior pentagon will be formed with its longest side parallel to the longest side of the base of the pyramid. From the ground line EH (fig. 21) raise the perpendicular IH, and make it equal to the altitude of the intended pyramid. To any point V draw the straight lines IV and HV, and by a process similar to that in Prob. 16, determine the scenographical altitudes *a*, *b*, *c*, *d*, *e*. Connect the upper points *f*, *g*, *h*, *i*, *k* by straight lines; and draw *lk*, *fm*, *gn*, and the perspective of the truncated pyramid will be completed.

Fig. 21.



Cor. If in a geometrical plane two concentric circles be described, a truncated cone may be put in perspective in the same manner as a truncated pyramid.

PROB. 17. *To put in perspective a hollow prism lying on one of its sides.*

Let ABDEC (fig. 22) be a section of such a prism. Draw HI parallel to AB, and distant from it the breadth of the side on which the prism rests; and from each angle internal and external of the prism let fall perpendiculars to HI. The parallelogram will be thus divided by the ichnographical process below the ground-line, so as that the side AB of the real prism will be parallel to the corresponding side of the scenographic view of it. To determine the altitude of the internal and external angles: from H (fig. 23) raise HI perpendicular to the ground-line, and on it mark off the true altitudes H1, H2, H3, H4, and H5. Then, if from any point V in the horizon be drawn the straight lines VH, V1, V2, V3, V4, V5, or VI; by a process similar to that of the preceding problem, will be determined the height of the internal angles, viz. 1=*aa*, 2=*bb*, 4=*dd;* and of the external angles, 3=*cc* and 5 = *ee;* and when these angles are formed and put in their proper places, the scenograph of the prism is complete.

Fig. 22.

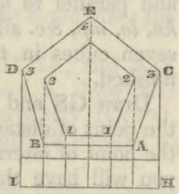
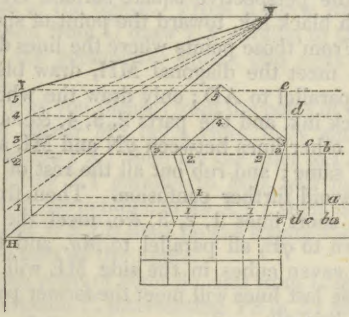


Fig. 23.



PROB. 18. *To put a square table in perspective standing on four upright square legs, of any given length with respect to the breadth of the table.*

In fig. 1, Plate CCCCVIII., let ABCD be the square part of the floor on which the table is to stand, and EFGH the surface of the square table, parallel to the floor.

Suppose the table to be three feet in breadth, and its height from the floor to be two feet; then two thirds of AD or EH will be the length of the legs *i* and *k;* the other two (*l* and *m*) being of the same length in perspective.

Having drawn the two equal and parallel squares ABCD and EFGH, as shown in Prob. 15, let the legs be square in form, and fixed into the table at a distance from its edges equal to their thickness. Take A*a* and D*d* equal to the intended thickness of the legs, and *ab* and *dc* also equal thereto. Draw the diagonals AC and BD, and draw straight lines from the points *a*, *b*, *c*, *d*, towards the point of sight S, and terminating at the side BC. Then, through the points where these lines cut the diagonals, draw the straight lines *n* and *o*, *p* and *q*, parallel to AD; and you will have formed four perspective squares (like ABCD in fig. 19) for the bases of the four legs of the table: and then it is easy to draw the four upright legs by parallel lines, all perpendicular to AD, and to shade them as in the figure.

To represent the intended thickness of the table-board, draw *eh* parallel to EH, and HG toward the point of sight S: then shade the spaces between these lines, and the perspective figure of the table will be finished.

PROB. 19. *To put five square pyramids in perspective, standing upright on a square pavement composed of the surfaces of eighty-one cubes.*

In fig. 1, Plate CCCCVI., let ABCD be a perspective square drawn according to the foregoing rules, S the point of sight, P the point of distance in the horizon PS, and AC and BD the two diagonals of the square.

Divide the side AD into nine equal parts (because 9 times 9 is 81) as A*a*, *ab*, *bc*, &c. and from these points of division *a*, *b*, *c*, *d*, &c. draw lines toward the point of sight S, terminating at the furthermost side BC of the square. Then, through the points where these lines cut the diagonals, draw straight lines parallel to AD, and the perspective square ABCD will be subdivided into eighty-one lesser squares, representing the upper surfaces of eighty-one cubes, laid close to one another's sides in a square form.

Draw AK and DL, each equal to A*a*, and perpendicular to AD; and draw LN toward the point of sight S: then draw KL parallel to AD, and its distance from AD will be equal to A*a*. This done, draw *al*, *bm*, *cn*, *do*, *ep*, *fq*, *gr*, and *hs*, all parallel to AK; and the space ADKL will be subdivided into nine equal squares, which are the outer upright surfaces of the nine cubes in the side AD of the square ABCD.

From the points where the lines which are parallel to AD in this square meet the side CD thereof, draw short lines to LN, all parallel to DL, and they will divide that side into the outer upright surfaces of the nine cubes which compose it; and then the outsides of all the cubes that can be visible to an observer, placed at a proper distance from the corner D of the square, will be finished.

As taught in Prob. 14, place the pyramid AE upright on its square base A*tva*, making it as high as you please; and the pyramid DH on its square base *huw*D, of equal height with AE.

Draw EH from the top of one of these pyramids to the top of the other; and EH will be parallel to AD.

Draw ES and HS to the point of sight S, and HP to the point of distance P, intersecting ES in F.

From the point F draw FG parallel to EH; then draw EG, and you will have a perspective square EFGH (parallel to ABCD) with its two diagonals EG and FH intersecting one another in the centre of the square at I. The four corners of this square, E, F, G, H, give the perspective heights of the four pyramids AE, BF, CG, and DH; and the intersection I of the diagonals gives the height of the pyramid MI, the centre of whose base is the centre of the perspective square ABCD.

Lastly, place the three pyramids BF, CG, MI, upright on their perspective bases at B, C, and M; and the required perspective representation will be finished as in the figure.

Prob. 20. *To put upright pyramids in perspective, on the sides of an oblong square or parallelogram, so that their distances from one another shall be equal to the breadth of the parallelogram.*

In most of the foregoing operations we have considered the observer to be so placed as to have an oblique view of the perspective objects: in this we shall suppose him to have a direct view of fig. 2, Plate CCCCVI., that is, standing right against the middle of the end AD which is nearest to his eye, and viewing AD under an angle of 60 degrees.

Having cut AD in the middle, by the perpendicular line S*s*, take S therein at pleasure for the point of sight, and draw ES for the horizon, parallel to AD. Here S*s* must be supposed to be produced downward, below the limits of the plate, to the place of the observer; and SE to be produced towards the left hand beyond E, far enough to take a proper point of distance therein, according to the foregoing rules.

Take A*d* at pleasure, and D*g* equal to A*d*, for the breadths of the square bases of the two pyramids AE and DF next the eye: then draw AS and *d*S, and likewise DS and *g*S, to the point of sight S; and DG on to the point of distance, intersecting AS in G: then from G draw GI parallel to AD; you will have the first perspective square AGID of the parallelogram ABCD.

From I draw IH to (or toward) the point of distance, intersecting AS in H: then, from H draw HK parallel to AD, and you will have the second perspective square GHKI of the parallelogram. Go on in this manner till you have drawn as many perspective squares up toward S as you please.

Through the point *e*, where DG intersects *g*S, draw *bf* parallel to AD; and you will have formed the two perspective square bases A*bcd* and *ef*D*g* of the two pyramids at A and D.

From the point *f* (the upper outward corner of *ef*D*g*) draw *fh* toward the point of distance, till it meets AS in *h*; then from this point of meeting draw *hm* parallel to GI, and you will have formed the two perspective squares G*hik* and *lm*I*n*, for the square bases of the two pyramids at G and I.

Proceed in the same manner to find the bases of all the other pyramids, at the corners of the rest of the perspective squares in the parallelogram ABCD, as shown by the figure. Then,

Having placed the first two pyramids at A and D upright on their square bases, as shown in Prob. 9, and made them of any equal heights at pleasure, draw ES and FS from the tops of these pyramids to the point of sight S: place all the rest of the pyramids upright on their respective bases, making their tops touch the straight lines ES and FS; and all the work, except the shading part, will be finished.

Prob. 21. *To put a square pyramid of equal-sized cubes in perspective.*

Fig. 3, Plate CCCCVI., represents a pyramid of this kind, consisting, as it were, of square tables of cubes, one table above another; 81 in the lowest, 49 in the next, 25 in the third, 9 in the fourth, and 1 in the fifth or uppermost. These are the square numbers of 9, 7, 5, 3, and 1.

If the artist is already master of all the preceding operations, he will find less difficulty in this than in attending to the following description of it; for it cannot be described in a few words, but may be executed in a very short time.

In fig. 4, Plate CCCCVI., having drawn PS for the horizon, and taken S for the point of sight therein (the observer being at O), draw AD parallel to PS for the side (next the eye) of the first or lowermost table of cubes. Draw AS and DS to the point of sight S, and DP to the point of distance P, intersecting AS in the point B. Then, from B draw BC parallel to AD, and you will have the surface ABCD of the first table.

Divide AD into nine equal parts, as A*a*, *ab*, *bc*, *cd*, &c. then make AK and DL equal to A*a*, and perpendicular to AD. Draw KL parallel to AD, and from the points of equal division at *a*, *b*, *c*, &c. draw lines to KL, all parallel to AK. Then draw *h*S to the point of sight S, and from the division points *a*, *b*, *c*, &c. draw lines with a black-lead pencil, all tending towards the point of sight, till they meet the diagonal BD of the square.

From these points of meeting draw black-lead lines to DC, all parallel to AD; then draw the parts of these lines with black ink which are marked 1, 2, 3, 4, &c. between *h*E and DC.

Having drawn the first of these lines βq with black ink, draw the parts *ai*, *bk*, *cl*, &c. (of the former lines which met the diagonal BD) with black ink also; and rub out the rest of the black-lead lines, which would otherwise confuse the following part of the work. Then draw LF toward the point of sight S; and from the points where the lines 1, 2, 3, 4, &c. meet the line DC, draw lines down to LF, all parallel to DL; and all the visible lines between the cubes in the first table will be finished.

Make *i*G equal and perpendicular to βi, and *q*M equal and parallel to *i*G; then draw GM, which will be equal and parallel to *iq*. From the points *k*, *l*, *m*, *n*, &c. draw *kn*, *lo*, *mp*, &c. all parallel to *i*G, and the outsides of the seven cubes in the side G*q* of the second table will be finished.

Draw GS and MS to the point of sight S, and MP to the point of distance P, intersecting GS in H; then, from the point of intersection H, draw HI parallel to AD; and you will have the surface GHIM of the second table of cubes.

From the points *n*, *o*, *p*, *q*, &c. draw black-lead lines toward the point of sight S, till they meet the diagonal MH of the perspective square surface GHIM; and draw SM, with black ink, toward the point of sight.

From those points where the lines drawn from *n*, *o*, *p*, *q*, &c. meet the diagonal MH, draw black-lead lines to MI, all parallel to AD; only draw the whole first line $\gamma 1$ with black ink, and the parts 2, 3, 4, &c. and *nt*, *ou*, *pv*, &c. of the other lines between *y*N and MI, and GM and $\gamma 1$, with the same; and rub out all the rest of the black-lead lines, to avoid further confusion. Then from the points where the short lines 1, 2, 3, &c. meet the line MI, draw lines down to *q*E, all parallel to M*q*, and the outer surfaces of the seven cubes in the side ME will be finished; and all these last lines will meet the former parallels 2, 3, 4, &c. in the line *q*E.

Make *t*O equal and perpendicular to γt, and *y*P equal and parallel to *t*O; then draw OP, which will be equal and parallel to *ty*. This done, draw OS and PS to the point of sight S, and PP to the point of distance P in the horizon. Lastly, from the point Q, where PP intersects OS, draw QR parallel to OP; and you will have the outlines OQRP of the surface of the third perspective table of cubes.

From the points *u*, *v*, *w*, *x*, draw upright lines to OP, all parallel to *t*O, and you will have the outer surfaces of the five cubes in the sides O*y* of this third table.

From the points where these upright lines meet OP, draw lines toward the point of sight S, till they meet the diagonal PQ; and from these points of meeting draw lines to PR, all parallel to OP, making the parts 2, 3, 4, 5, of these lines with black ink which lie between ZY and PR. Then, from the points where these lines meet PR, draw lines down to *y*N, which will bound the outer surfaces of the five cubes in the side PN of the third table.

Draw the line δ1 with black ink; and, at a fourth part of its length between δ and Z, draw an upright line to S, equal in length to that fourth part, and another equal and parallel thereto from Z to V: then draw SV parallel to δZ, and draw the two upright and equidistant lines between δZ and SV, and you will have the outer surfaces of the three cubes in the side SZ of the fourth table.

Draw SS and VS to the point of sight S in the horizon, and VP to the point of distance therein, intersecting SS in T; then draw TU parallel to SV, and you have STUV, the surface of the fourth table, which being reticulated or divided into nine perspective small squares, and the uppermost cube W placed on the middlemost of the squares, all the outlines will be finished; and when the whole is properly shaded, as in Plate CCCCVI. fig. 3, the work will be done.

Prob. 22. *To represent a double cross in perspective.*

In fig. 5, Plate CCCCVI., let ABCD and EFGH be the two perspective squares, equal and parallel to one another, the uppermost directly above the lowermost, drawn by the rules already laid down, and as far asunder as is equal to the given height of the upright part of the cross; S being the point of sight, and P the point of distance, in the horizon PS taken parallel to AD.

Draw AE, DH, and CG; then AEHD and DHGC shall be the two visible sides of the upright part of the cross; of which the length AE is here made equal to three times the breadth EH.

Divide DH into three equal parts, HI, IK, and KD. Through these points of division, at I and K, draw MO and PR parallel to AD; and make the parts MN, IO, PQ, KR, each equal to HI; then draw MP and OR parallel to DH.

From M and O draw MS and OS to the point of sight S; and from the point of distance P draw PN, cutting MS in T: from T draw TU parallel to MO, and meeting OS in U; and you will have the uppermost surface MTUO of one of the cross pieces of the figure. From R draw RS to the point of sight S; and from U draw UV parallel to OR; and OUVR shall be the perspective square end next the eye of that cross part.

Draw PMX (as long as you please) from the point of distance P, through the corner M; lay a ruler to N and S, and draw XN from the line PX: then lay the ruler to I and S, and draw YZS. Draw XY parallel to MO, and make XW and YB equal and perpendicular to XY: then draw WB parallel to XY, and WXYB shall be the square visible end of the other cross part of the figure.

Draw BK toward the point of sight S; and from U draw UP to the point of distance P, intersecting YS in Z: then, from the intersection Z draw Z*a* parallel to MO, and Z*b* parallel to HD, and the whole delineation will be finished.

This done, shade the whole, as in fig 6, Plate CCCCVI., and you will have a true perspective representation of a double cross.

Prob. 23. *To put three rows of upright square objects in perspective, equal in size, and at equal distances from each other, on an oblong square plane, the breadth of which shall be of any assigned proportion to the length thereof.*

Fig. 7, Plate CCCCVI., is a perspective representation of an oblong square plane, three times as long as it is broad, having a row of nine upright square objects on each side, and one of the same number in the middle; all equally high, and at equal distances from one another, both longwise and crosswise, on the same plane.

In fig. 8, Plate CCCCVI., PS is the horizon, S the point of sight, P the point of distance, and AD (parallel to PS) the breadth of the plane.

Draw AS, NS, and DS, to the point of sight S; the point N being in the middle of the line AD: and draw DP to the point of distance P, intersecting at AS in the point B: then, from B draw BC parallel to AD, and you have the perspective square ABCD.

Through the point *i*, where DB intersects NS, draw *ae* parallel to AD; and you will have subdivided the perspective square ABCD into four lesser squares, as *ai*N, N*ie*D, *a*B*ki*, and *ik*C*e*.

From the point C (at the top of the perspective square ABCD) draw CP to the point of distance P, intersecting AS in E; then from the point E draw EF parallel to AD; and you will have the second perspective square BEFC.

Through the point *l*, where CE intersects NS, draw *bf* parallel to AD; and you will have subdivided the square BEFC into the four squares B*blk*, *klf*C, *b*E*ml*, and *lm*F*f*.

From the point F (at the top of the perspective square BEFC) draw FP to the point of distance P, intersecting AS in I; then from the point I draw IK parallel to AD; and you will have the third perspective square EIKF.

Through the point *n*, where FI intersects NS, draw *cg* parallel to AD; and you will have subdivided the square EIKF into four lesser squares, E*cnm*, *mng*F, *c*I*on*, and *no*K*g*.

From the point K (at the top of the third perspective square EIKF) draw KP to the point of distance P, intersecting AS in L; then from the point L draw LM parallel to AD; and you will have the fourth perspective square ILMK.

Through the point *p*, where KL intersects NS, draw *dh* parallel to AD; and you will have subdivided the square ILMK into the four lesser squares I*dpo*, *oph*K, *d*L*qp*, and *pq*M*h*.

Thus we have formed an oblong square ALMD, whose perspective length is equal to four times its breadth, and it contains sixteen equal perspective squares. If greater length was still wanted, we might proceed farther on toward S.

Take A3, equal to the intended breadth of the side of the upright square object AQ (all the other sides being of the same breadth), and AO for the intended height. Draw O 18 parallel to AD, and make D 8 and 4 7 equal to A 3; then draw 3 S, 4 S, 7 S, and 8 S to the point of sight S; and among them we shall have the perspective square bases of all the twenty-seven upright objects on the plane.

Through the point 9, where DB intersects 8 S, draw 1 10 parallel to AD, and you have the three perspective square bases A 1 2 3, 4 5 6 7, 8 9 10 D, of the three upright square objects at A, N, and D.

Through the point 21, where *eb* intersects 8 S, draw 14, 11 parallel to AD; and you will have the three perspective squares *a* 14 15 16 17 18 19 20, and 21 11 *e* 22, for the bases of the second cross row of objects; namely, the next beyond the first three at A, N, and D.

Through the point *w*, where CE intersects 8 S, draw a line parallel to BC; and you will have three perspective squares, at B, *k*, and C, for the bases of the third row of objects; one of which is set up at B.

Through the point *x*, where *fc* intersects 8 S, draw a line parallel to *bf;* and you will have three perspective squares, at *b*, *l*, and *x*, for the bases of the fourth cross row of objects.

Go on in this manner, as you see in the figure, to find the rest of the square bases, up to LM; and you will have 27 upon the whole oblong square plane, on which you are to place the like number of objects, as in fig. 7, Plate CCCCVI.

Having assumed AO for the perspective height of the three objects at A, N, and D (Plate CCCCVI. fig. 8) next the observer's eye, and drawn O 18 parallel to AD, in order to make the objects at N and D of the same height as that at O; and having drawn the upright lines 4 15, 7 W, 8 X, and D 22, for the heights at N and D; draw OS and RS, 15 S and WS, XS and 22 S, all to the point of sight S; and these lines will determine the perspectively equal heights of all the rest of the upright objects, as shown by the two placed at *a* and B.

To draw the square tops of these objects, equal and parallel to their bases, we need only give one example, which will serve for all.

Draw 3 R and 2 Q parallel to AO, and up to the line RS; then draw PQ parallel to OR, and OPQR shall be the top of the object at A, equal and parallel to its square base A 1 2 3. In the same easy way the tops of all the other objects are formed.

When all the rest of the objects are delineated, shade them properly, and the whole perspective scheme will have the appearance of fig. 7, Plate CCCCVI.

PROB. 24. *To put a square box in perspective, containing a given number of lesser square boxes of a depth equal to their width.*

Let the given number of little square boxes or cells be sixteen; then four of them make the length of each side of the four outer sides *ab*, *bc*, *cd*, *da*, as in Plate CCCCVII. fig. 9, and the depth *af* is equal to the width *ae*. Whoever can draw the reticulated square by the rules laid down towards the beginning of this article, will be at no loss about putting this perspective scheme in practice.

PROB. 25. *To put stairs with equal and parallel steps in perspective.*

In fig. 10, Plate CCCCVII., let *ab* be the given breadth of each step, and *ai* the height thereof. Make *bc*, *cd*, *de*, &c. each equal to *ab*, and draw all the upright lines *ai*, *bl*, *cn*, *dp*, &c. perpendicular to *ah* (to which the horizon *s*S is parallel); and from the points *i*, *l*, *n*, *p*, *r*, &c. draw the equidistant lines *i*B, *l*C, *n*D, &c. parallel to *ah;* these distances being equal to that of *i*B from *ah*.

Draw *xi* touching all the corner-points *l*, *n*, *p*, *r*, *t*, *v;* and draw 2 16 parallel to *xi*, as far from it as you want the length of the steps to be.

Toward the point of sight S draw the lines *a*1, *i*2, *k*3, *l*4, &c. and draw 16 15, 14 13, 12 11, 10 9, 8 7, 6 5, 4 3, and 2 1, all parallel to A*h*, and meeting the lines *w* 15, *u* 13, *s* 11, &c. in the points 15, 13, 11, 9, 7, 5, 3, and 1: then from these points draw 15 14, 13 12, 11 10, 9 8, 7 6, 5 4, and 3 2, all parallel to *ha;* and the outlines of the steps will be finished. From the point 16 draw 16 A parallel to *ha*, and A*x* 16 will be the part of the flat at the top of the uppermost step. This done, shade the work as in fig. 11, Plate CCCCVII., and the whole will be finished.

PROB. 26. *To put stairs with flats and opening in perspective, standing on a horizontal pavement of squares.*

In fig. 12, Plate CCCCVII., having made S the point of sight, and drawn a reticulated pavement AB with black-lead lines, which may be rubbed out again; at any distance from the side AB of the pavement which is nearest to the eye, and at any point where you choose to begin the stair at that distance, as *a*, draw G*a* parallel to BA, and take *ab* at pleasure for the height of each step.

Take *ab* in your compasses, and set that extent as many times upward from F to E as is equal to the first required number of steps O, N, M, L, K; and from these points of division in EF draw 1*b*, 2*d*, 3*f*, 4*h*, and E*k*, all equidistant from one another, and parallel to F*a;* then draw the equidistant upright lines *ab*, *td*, *uf*, *vh*, *wk*, and I*m*, all perpendicular to F*a;* then draw *mb*, touching the outer corners of these steps at *m*, *k*, *h*, *f*, *d*, and *b;* and draw *ns* parallel to *mb*, as far from it as you want the length of the steps K, L, M, N, O to be.

Towards the point of sight S draw *mn*, *l*5, *ko*, *i*6, *hp*, *fq*, *dr*, and *bs*. Then (parallel to the bottom-line BA) through the points *n*, *o*, *p*, *q*, *r*, *s*, draw *n*8; 5, 14; 6, 15; 7, 16; 1, 17; and 2*s;* which done, draw *n*5 and *o*6 parallel to *lm*, and the outlines of the steps K, L, M, N, O will be finished.

At equal distances with that between the lines marked 8 and 14, draw the parallel lines above, marked 9, 10, 11, 12, and 13; and draw perpendicular lines upwards from the points *n*, *o*, *p*, *q*, *r*, *s*, as in the figure.

Make H*m* equal to the intended breadth of the flat above the square opening at the left hand, and draw HW toward the point of sight S, equal to the intended length of the flat; then draw WP parallel to H*m*, and the outlines of the flat will be finished.

Take the width of the opening at pleasure, as from F to C, and draw CD equal and parallel to FE. Draw GH parallel to CD, and the short lines marked 33, 34, &c. just even with the parallel lines 1, 2, &c. From the points where these short lines meet CD, draw lines toward the point of sight S till they meet DE; then from the points where the lines 38, 39, 40, &c. of the pavement meet C*y*, draw upright lines parallel to CD; and the lines which form the opening will be finished.

The steps P, Q, R, S, T, and the flat U above the arch V, are done in the same manner with those in fig. 10, as taught in Prob. 25, and the equidistant parallel lines marked 18, 19, &c. are directly even with those on the left-hand side of the arch V, and the upright lines on the right-hand side are equidistant with those on the left.

From the points where the lines 18, 19, 20, &c. meet the right-hand side of the arch, draw lines toward the point of sight S; and from the points where the pavement lines 29, 30, 31, 32, meet the line drawn from A towards the point of sight, draw upright lines toward the top of the arch.

Having done the top of the arch, as in the figure, and the few steps to the right hand thereof, shade the whole, as in fig. 13, Plate CCCCVII., and the work will be finished.

PROB. 27. *To put upright conical objects in perspective, as if standing on the sides of an oblong square, at distances from one another equal to the breadth of the oblong.*

In fig. 14, Plate CCCCVII., the bases of the upright cones are perspective circles inscribed in squares of the same diameter; and the cones are set upright on their bases by the same rules as are given for pyramids, which we need not repeat here.

In most of the foregoing operations we have considered the observer's eye to be above the level of the tops of all the objects, as if he viewed them when standing on high ground. In this figure, and in fig. 17 and fig. 18, Plate CCCCVIII., we shall suppose him to be standing on low ground, and the tops of the objects to be above the level of his eye.

In fig. 14, Plate CCCCVII., let AD be the perspective breadth of the oblong square ABCD; and let A*a* and D*d* (equal to A*a*) be taken for the diameters of the circular bases of the two cones next the eye, whose intended equal heights shall be AE and DF.

Having made S the point of sight in the horizon parallel to AD, and found the proper point of distance therein, draw AS and *a*S to contain the bases of the cones on the left-hand side, and DS and *d*S for those on the right.

Having made the two first cones at A and D of equal height at pleasure, draw ES and FS from their tops to the point of sight, for limiting the perspective heights of all the rest of the cones. Then divide the parallelogram ABCD into as many equal perspective squares as you please; find the bases of the cones at the corners of these squares, and make the cones thereon, as in the figure.

If you would represent a ceiling equal and parallel to ABCD, supported on the tops of these cones, draw EF, then EFGH shall be the ceiling; and by drawing *ef* parallel to EF, you will have the thickness of the floor-boards and beams, which may be what you please.

This shows how any number of equidistant pillars may be drawn of equal heights to support the ceiling of a long room, and how the walls of such a room may be represented in perspective at the backs of these pillars. It also shows how a street of houses may be drawn in perspective.

Prob. 28. *To put a square hollow in perspective, the depth of which shall bear any assigned proportion to its width.*

Fig. 17, Plate CCCCVIII., is the representation of a square hollow, of which the depth AG is equal to three times its width AD; and S is the point of sight over which the observer's eye is supposed to be placed, looking perpendicularly down into it, but not directly over the middle.

Draw AS and DS to the point of sight S; make ST the horizon parallel to AD, and produce it to such a length beyond T that you may find a point of distance therein not nearer S than if AD were seen under an angle of sixty degrees.

Draw DU to the point of distance, intersecting AS in B; then from the point B draw BC parallel to AD; and you will have the first perspective square ABCD, equal to a third part of the intended depth.

Draw CV to the point of distance, intersecting AS in E; then from the point E draw EF parallel to AD; and you will have the second perspective square BEFC, which, added to the former one, makes two thirds of the intended depth.

Draw FW to the point of distance, intersecting AS in G; then from the point G draw GH parallel to AD; and you will have the third perspective square EGHF, which, with the former two, makes the whole depth AGHD three times as great as the width AD, in a perspective view.

Divide AD into any number of equal parts, as suppose 8; and from the division points *a*, *b*, *c*, *d*, &c. draw lines toward the point of sight S, and ending at GH; then through the points where the diagonals BD, EC, GF, cut these lines, draw lines parallel to AD; and you will have the parallelogram AGHD reticulated, or divided into 192 small and equal perspective squares.

Make AI and DM equal and perpendicular to AD; then draw IM, which will be equal and parallel to AD; and draw IS and MS to the point of sight S.

Divide AI, IM, and MD into the same number of equal parts as AD is divided; and from these points of division draw lines toward the point of sight S, ending respectively at GK, KL, and LH.

From those points where the lines parallel to AD meet AG and DH, draw upright lines parallel to AI and DM; and from the points where these lines meet IK and LM draw lines parallel to IM; then shade the work, as in the figure.

Prob. 29. *To represent a semicircular arch in perspective, as if it were standing on two upright walls, equal in height to the height of the observer's eye.*

After having gone through the preceding operation, this will be more easy by a bare view of fig. 18, Plate CCCCVIII., than it could be made by any description; the method being so much like that of drawing and shading the square hollow. We need only mention, that *a*T*b*EA and DF*ctd* are the upright walls on which the semicircular arch is built; that S is the point of sight in the horizon T*t*, taken in the centre of the arch; and *d* in fig. 17 is the point of distance; and that the two perspective squares ABCD and BEFC make the parallelogram AEFD of a length equal to twice its breadth AD.

Prob. 30. *To represent a square in perspective, as viewed by an observer standing directly even with one of its corners.*

In fig. 19, Plate CCCCVIII., let A9BC be a true square, viewed by an observer standing at some distance from the corner C, and just even with the diagonal C9.

Let *p*SP be the horizon, parallel to the diagonal AB; and S the point of sight, even with the diagonal C9. Here it will be proper to have two points of distance, *p* and P, equidistant from the point of sight S.

Draw the straight line 1 17 parallel to AB, and draw A8 and B10 parallel to CS. Take the distance between 8 and 9 in your compasses, and set it off all the way in equal parts from 8 to 1, and from 10 to 17. The line 1 17 should be produced a good way farther both to right and left hand from 9, and divided all the way in the same manner.

From these points of equal division, 8, 9, 10, &c. draw lines to the point of sight S, and also to the two points of distance *p* and P, as in the figure.

Now it is plain that *acb*9 is the perspective representation of A9BC, viewed by an observer even with the corner C and diagonal C9. But if there are other such squares lying even with this, and having the same position with respect to the line 1 17, it is evident that the observer, who stands directly even with the corner C of the first square, will not be even with the like corners G and K of the others; but will have an oblique view of them, over the sides FG and IK, which are nearest his eye: and their perspective representations will be *egf*6 and *hki*3, drawn among the lines in the figure; of which the spaces taken up by each side lie between three of the lines drawn toward the point of distance *p*, and three drawn to the other point of distance P.

Prob. 31. *To represent a common chair, in an oblique perspective view.*

The original lines to the point of sight S, and points of distance *p* and P (Plate CCCCVIII. fig. 19), being drawn as in the preceding operation, choose any part of the plane, as *lmn*13, on which you would have the chair L to stand. There are just as many lines (namely two) between *l* and *m* or 13 and *n*, drawn toward the point of distance *p*, at the left hand, as between *l* and 13, or *m* and *n*, drawn to the point of distance P on the right: so that *lm*, *mn*, *n*13, and 13*l*, form a perspective square.

From the four corners *l*, *m*, *n*, 13, of this square raise the four legs of the chair to the perspective perpendicular height you would have them: then make the seat of the chair a square equal and parallel to *lmn*13, as taught in Prob. 15, which will make the two sides of the seat in the direction of the lines drawn toward the point of distance *p*, and the fore and back part of the seat in direction of the lines drawn to the other point of distance P. This done, draw the back of the chair leaning a little backward, and the cross bars therein tending toward the point of distance P. Then shade the work as in the figure, and the perspective chair will be finished.

Prob. 32. *To present an oblong square table in an oblique perspective view.*

In fig. 19, Plate CCCCVIII., M is an oblong square table, as seen by an observer standing directly even with C9 (see Prob. 30), the side next the eye being perspectively parallel to the side *ac* of the square *abc*9. The forementioned lines drawn from the line 1 17 to the two points of distance *p* and P, form equal perspective squares on the ground plane.

Choose any part of this plane of squares for the feet of the table to stand upon; as at *p*, *q*, *r*, and *s*, in direction of the lines *op* and *rs* for the two long sides, and *ts* and *qr* for the two ends; and you will have the oblong square or parallelogram *qrst* for the part of the floor or ground-plane whereon the table is to stand: and the breadth of this plane is here taken in proportion to the length as 6 to 10; so that, if the length of the table be ten feet, its breadth will be six.

On the four little perspective squares at *q*, *r*, *s*, and *t*, place the four upright legs of the table, of what height you please, so that the height of the two next the eye, at *o* and *p*, shall be terminated by a straight line *uv* drawn to the point of distance P. This done, make the leaf M of the table an oblong square, perspectively equal and parallel to the oblong square *qrst* on which the feet of the table stands. Then shade the whole, as in the figure, and the work will be finished.

If the line 1 17 were prolonged to the right and left hand, and equally divided throughout (as it is from 1 to 17), and if the lines which are drawn from *p* and P to the right and left hand sides of the plate were prolonged till they came to the extended line 1 17, they would meet it in the equal points of division. In forming large plans of this sort, the ends of slips of paper may be pasted to the right and left edges of the sheet on which the plan is to be formed.

Of the Anamorphosis, or reformation of distorted images.

By this means, pictures that are so mishapen as to exhibit no regular appearance of any thing to the naked eye, shall, when viewed by reflection, present a regular and beautiful image. The inventor of this ingenious device is not known. Simon Stevinus, who was the first that wrote upon it, does not inform us from whom he learned it. The principles of it are laid down by S. Vauzelard, in his *Perspective Conique et Cylindrique*; and Gaspar Schott professes to copy Marius Bettinus in his description of this piece of artificial magic.

It will be sufficient for our purpose to copy one of the simplest figures of this writer, as by this means the mystery of this art will be sufficiently unfolded. Upon the cylinder of paper, or pasteboard, ABCD, fig. 16, Plate CCCCVIII., draw whatever is intended to be exhibited, as the letters IHS. Then with a needle make perforations along the whole outline; and placing a candle G behind this cylinder, mark upon the ground-plane the shadow of them, which will be distorted more or less, according to the position of the candle or the plane, &c. This being done, let the picture be an exact copy of this distorted image, let a metallic speculum be substituted in the place of the cylinder, and let the eye of the spectator have the same position before the cylinder that the candle had behind it. Then looking upon the speculum, he will see the distorted image restored to its proper shape. The reformation of the image, he says, will not easily be made exact in this method, but it will be sufficiently so to answer the purpose.

Other methods, more exact and geometrical than this, were found out afterwards: so that these pictures could be drawn by certain rules, without the use of a candle. Schott quotes one of these methods from Bettinus, another from Herigonius, and another from Kircher, which may be seen in his *Magia*, vol. i. p. 162, &c. He also gives an account of the methods of reforming pictures by speculums of conical and other figures.

Instead of copying any of these methods from Schott or Bettinus, we shall present our readers with that which Dr Smith hath given us in his Optics, vol. i. p. 250, as, no doubt, the best, and from which any person may easily make a drawing of this kind. The same description answers to two mirrors, one of which, fig. 24, is convex, and the other, fig. 25, is concave.

Fig. 24.

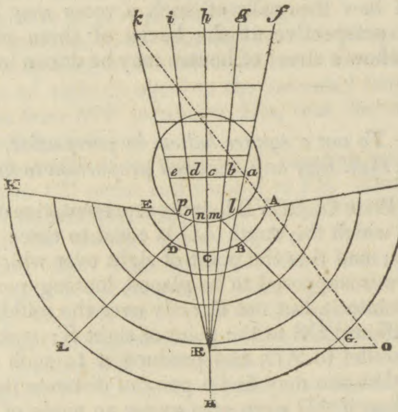
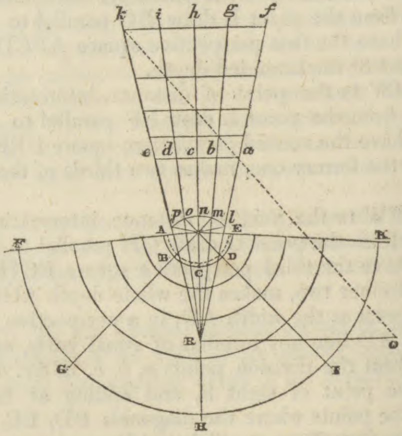


Fig. 25.



In order to paint upon a plane a deformed copy, ABCDEKIHGF, of an original picture, which shall appear regular when seen from a given point O, elevated above the plane, by rays reflected from a polished cylinder, placed upon the circle *lnp*, equal to its given base; from the point R, which must be supposed to lie perpendicularly under O, the place of the eye, draw two lines R*a*, R*e*, which shall either touch the base of the cylinder, or else cut off two small equal segments from the sides of it, according as the copy is intended to be more or less deformed. Then, taking the eye, raised above R, to the given height RO, somewhat greater than that of the cylinder, for a luminous point, describe the shadow *aekf* (of a square, fig. 24, or parallelogram standing upright upon *ae* as a base, and containing the picture required) anywhere behind the arch *lnp*. Let the lines drawn from R to the extremities and divisions of the base *a*, *b*, *c*, *d*, *e*, cut the remotest part of the shadow in the points *f*, *g*, *h*, *i*, *k*, and the arch of the base in *l*, *m*, *n*, *o*, *p*; from which points draw the lines *l*AF, *m*BG, *n*CH, *o*DI, *p*EK, as if they were rays of light that came from the focus R, and were reflected from the base *lnp*; so that each couple, *l*A, *l*R, produced, may cut off equal segments from the circle. Lastly, transfer the lines *laf*, *mbg*, &c. and all their parts in the same order, upon the respective lines *l*AF, *m*BG, &c. and having drawn regular curves, by estimation, through the points A, B, C, D, E, through F, G, H, I, K, and through every intermediate order of points; the figure ACEKHF, so divided, will be the deformed copy of the square, drawn and divided upon the original picture, and will appear similar to it, when seen in the polished cylinder, placed upon the base *lnp*, by the eye in its given place O.

The practical methods of drawing these images seem to have been carried to the greatest perfection by J. Leopold, who, in the *Acta Lipsiensia* for the year 1712, has described two machines, one for the images to be viewed with a cylindrical and the other with a conical mirror. The person possessed of this instrument has nothing to do but to take any print he pleases, and while he goes over the outlines of it with one pen, another traces the anamorphosis.

By methods of this kind, groves of trees may be cut, so as to represent the appearance of men, horses, and other objects, from some one point of view, which are not at all discernible in any other. This might easily be effected by one person placing himself in any particular situation, and giving directions to other persons what trees to lop, and in what manner. In the same method it has been contrived, that buildings of circular and other forms, and also whole groups of buildings consisting of walls at different distances, and with different positions to one another, should be painted so as to exhibit the exact representation of particular objects, which could only be perceived in one situation. Bettinus has illustrated this method by drawings in his *Apiaria*.

It may appear a bold assertion to say, that the very short sketch now given of the art of perspective is a sufficient foundation for the whole practice, and includes *all* the expeditious rules peculiar to the problems which most generally occur. It is, however, true; and the intelligent reader will perceive, that the two theorems on which the whole rests include every possible case, and apply with equal facility to pictures and originals in any position, although the examples are selected of perpendicular pictures, and of originals referred to horizontal planes, as being the most frequent. The scientific foundation being so simple, the structure need not be complex, nor swell into such volumes as have been published on the subject; which by their size deter from the perusal, and give the simple art the appearance of intricate mystery, whilst, by their prices, they defeat the design of their authors to promote the dissemination of knowledge amongst practitioners. The treatises on perspective acquire their bulk by long and tedious discourses, minute explanations of common things, or by great numbers of examples; which indeed render some of these books valuable from the variety of curious cuts, but do not at all instruct the reader by any improvements made in the art itself. For it is evident that most of those who have treated this subject have been more conversant in the practice of designing than in the principles of geometry; and therefore when, in their practice, the cases which have occurred put them upon trying particular expedients, they have thought them worth communicating to the public as improvements in the art; and each author, fond of his own little expedient, which by a scientific person would have been known as an easy corollary from the general theorem, has made it the principle of a practical system, thus narrowing instead of enlarging the knowledge of the art; and the practitioner, tired of the bulk of the volume, in which a single maxim is tediously spread out, and the principle on which it is founded kept out of his sight, contents himself with a remembrance of a maxim perhaps not understood, and keeps it slightly in his eye to avoid gross errors. We can appeal to the whole body of painters and draughtsmen for the truth of this assertion; and it must not be considered as an imputation of remissness or negligence on their part, but as a necessary consequence of the ignorance of the authors from whom they have taken their information. This is a strong statement, but it is not the less just. Several mathematicians of eminence have written on perspective, treating it as the subject of pure geometry, as it really is; and the performances of Dr Brooke Taylor, Gravesande, Wolf, De la Caille, and Emerson, are truly valuable, by presenting the art in all its perspicuous simplicity and universality. The works of Taylor and Emerson are more valuable, on account of the very ingenious and expeditious constructions which they have given, suited to every possible case. The merit of the former has been universally acknowledged by all the British writers on the subject, who never fail to declare that their own works are composed on the principle of Dr Brooke Taylor; but any man of science will see that these authors have either not understood them, or aimed at pleasing the public by fine cuts and uncommon cases; for, without exception, they have omitted his favourite constructions, which had gained his predilection by their universality, and attached themselves to inferior methods, or perhaps to inventions which they were pleased to regard as their own. What has been laid down in this article is not *professed* to be according to the principles of Dr Brooke Taylor, because the principles are not peculiar to him, but the necessary results of the theory itself, and inculcated by every mathematician who has taken the trouble to consider the subject. They are sufficient not only for directing the ordinary practice, but likewise for suggesting modes of construction in every case out of the common track. A person of ingenuity will have a laudable enjoyment in inventing rules for himself, and will be better pleased with such fruits of his own ingenuity, than in reading the tedious explanation of examples devised by another; and with this view we would, with Dr Taylor, "advise all our readers not to be contented with the scheme they find here; but, on every occasion, to draw new ones of their own, in all the variety of circumstances they can think of. This will take up more time at first, but they will find the vast benefit and pleasure of it by the extensive notions it will give them of the nature of the principles."

The art of perspective is necessary to those arts where there is any occasion for designing, as architecture, fortification, carving, and generally to all the mechanical arts; but it is more particularly necessary to the art of painting, in which nothing can be done without it. A figure in a picture, which is not drawn according to the rules of perspective, does not represent what is intended, but something else. Indeed, we hesitate not to say, that a picture which is faulty in this particular is as blameable as any composition in writing which is defective in point of orthography or grammar. It is generally thought very ridiculous to pretend to write a heroic poem, or a fine discourse, upon any subject, without understanding the propriety of the language in which we write; and to us it seems no less ridiculous for one to pretend to paint a good picture without understanding per-

Perspective, Aerial.

spective. Yet how many pictures are there to be seen, which are highly valuable in other respects, and yet are entirely faulty in this point? Indeed, this fault is so very general, that we cannot remember ever having seen a picture which is entirely free from it; and, what is more to be regretted, the greatest masters have been the most guilty of it. Such examples cause it to be overlooked; but the fault is not the less, but the more to be lamented, and deserves the greater care in avoiding it for the future. The great occasion of this fault is certainly the bad method which is generally used in educating persons in this art; for the young people are generally put immediately to drawing, and when they have acquired a facility in that, they are put to colouring. And these things they learn by rote, or by practice only, and are not at all instructed in any rules of art; by which means, when they come to make any designs of their own, though they are very expert at drawing and colouring every thing which offers itself to their fancy, yet for want of being instructed in the strict rules of art, they do not know how to govern their inventions with judgment, and become guilty of many gross mistakes, which prevent themselves, as well as others, from finding the satisfaction which they otherwise would do in their performances. To correct this defect, we would recommend it to masters of the art of painting to consider whether it would not be necessary to establish a better method for the education of their scholars, and to begin their instructions with the technical parts of painting, before they let them loose to follow the inventions of their own uncultivated imaginations.

The art of painting, taken in its full extent, consists of two parts; the inventive and the executive. The inventive part is common to poetry, and belongs more properly and immediately to the original design (which it conceives and disposes in the most proper and agreeable manner) than to the picture, which is only a copy of that design already formed in the imagination of the artist. The perfection of this art depends upon the thorough knowledge the artist has of all the parts of his subject; and the beauty of it consists in the happy choice and disposition which he makes of it. It is in this that the genius of the artist discovers and shows itself, whilst he indulges and humours his fancy, which here is not confined. But the executive part of painting is wholly confined and restricted to the rules of art, which cannot upon any account be dispensed with; and therefore in this the artist ought to govern himself entirely by these rules, and not to take any liberties whatsoever. For any thing that is not truly drawn according to the rules of perspective, or not truly coloured or truly shaded, does not appear to be what the artist intended, but something else. Wherefore, if at any time the artist happen to imagine that his picture would look better if he swerved a little from these rules, he may assure himself, that the fault belongs to his original design, and not to the strictness of the rules; for what is perfectly agreeable and just in the real original objects themselves, can never appear defective in a picture where these objects are accurately copied.

Therefore, to offer a short hint of the thoughts we have some time had as to the method which ought to be followed in instructing a scholar in the executive part of painting, we would first have him to learn the most common principles of practical geometry, and the elements of plain geometry and of common arithmetic. When he is sufficiently perfect in these, we would next have him to learn perspective; and when he has made considerable progress in the latter, so as to prepare his judgment with right notions of the alterations which figures must undergo, when they come to be drawn upon a flat surface, he may then be put to drawing by view, and be exercised in this alone with perspective, till he comes to be sufficiently perfect in both. Nothing should be more familiar to a painter than perspective; for it is the only thing which can make the judgment correct, and help the fancy to invent with ten times the ease that it could do without it.

We earnestly recommend to our readers the careful perusal of Dr Taylor's Treatise, as published by Colson in 1749, and Emerson's, published along with his Optics, as still the best *scientific* works on the subject. (B. B. B.)

PERSPECTIVE, Aerial, is sometimes employed as a general denomination for that which in a more restricted sense is called *aerial perspective*, or the art of giving a due diminution or degradation to the strength of light, shade, and colour, according to the different distances of objects, the quantity of light which falls upon them, and the medium through which they are seen; the *chiaro oscuro*, which consists in expressing the different degrees of light, shade, and colour of bodies, arising from their own shape, and the position of their parts with respect to the eye and neighbouring objects, by which their light or colours are affected; and *keeping*, which is the observance of a due proportion in the general light and colouring of the whole picture, so that no light or colour in one part may be too bright or too strong for another. A painter who would succeed in *aerial perspective* ought carefully to study the effects which distance, or different degrees or colours of light, have on each particular original colour, to know how its hue or strength is changed in the several circumstances which occur, and to represent it accordingly. As all objects in a picture take their measures in proportion to those which are placed in the front, so, in *aerial perspective*, the strength of light, and the brightness of the colours of objects close to the picture, must serve as a measure, with respect to which all the same colours at several distances must have a proportional degradation in like circumstances.

Bird's eye view in Perspective, is that which supposes the eye to be placed above any building, or other object, as in the air at a considerable distance from it. This is applied in drawing the representations of fortifications, when it is necessary not only to exhibit one view as seen from the ground, but also so much of the several buildings as the eye can possibly take in at one time from any situation. In order to this, we must suppose the eye to be removed to a considerable height above the ground, and to be placed, as it were, in the air, so as to look down into the building like a bird when flying. In representations of this kind, the higher the horizontal line is placed, the more of the fortification will be seen, and *vice versa*.

PERTH, the principal town of Perthshire, and the most central in Scotland, is situated on the banks of the river Tay, about twenty-five miles above its confluence with the German Ocean, in latitude 56. 23. 40. north, and longitude 3. 26. 20. west. The situation of Perth is one of the finest that can be imagined. Two beautiful and extensive meadows, called the North Inch and South Inch, bound it upon two sides. On the east it is washed by the waters of the Tay, whilst on the west and the south-west it is surrounded by a screen of hills, of moderate elevation, but richly wooded, and sloping gently down towards the town and the river. Of these hills, or rather eminences, the highest is that of Moncrieff, which is 756 feet above the level of the sea; but the landscape that opens to the eye from its summit is one of the finest in Scotland, comprehending in the northern distance a noble sweep of the Grampian Mountains, and presenting to the westward a splendid view of Strathearn, intersected by the numerous windings of its river; whilst to the east appear the Carse of Gowrie, rich in all the beauties of fertility, and the majestic Tay rolling onwards to the sea. The site of Perth is remarkably low, being only a few feet above the level of the sea; but notwithstanding this circumstance, and the vicinity of hills, the climate is not particularly moist, and is considered as healthy. The lowness of the situation, however, exposes the town to frequent inundations from the river, several of which make rather a formidable appearance in its annals. The greatest of these upon record appears to have happened in the reign of William the Lion, who is said to have narrowly escaped with his family and court, from the sudden rising of the waters. The years 1621, 1773, and 1814 are also memorable in the burgh records for similar and equally extensive casualties. The deepening of the Tay below the town, which has been in progress for some years, will, however, ultimately lessen the dangers to be apprehended from these sudden inundations, by affording a deeper and freer channel for the waters of the river.

Perth is one of the most ancient towns in Scotland, and its civil history, up to the sixteenth century, is deeply interwoven with the national annals. Its origin is buried in the obscurity of the past, and the very etymology of its name is uncertain.[1] For many centuries it was called St Johnston, which appears indeed to have been its most ancient designation. This name was, it seems, given to it from the circumstance of the first church erected in it, after the conversion of the inhabitants to Christianity, being dedicated to St John the Baptist; a circumstance which is in some degree confirmed by the ancient seal of the burgh, on which is represented the martyrdom of the saint. The city records are very ancient, but are not legible farther back than the year 1512. From that period they are very complete, and contain matter equally curious and interesting to the historian and the antiquary. Indeed, some of our early historians are of opinion that the town was founded by the Roman general Agricola, who erected a citadel to maintain his conquests, and check the wild spirit of the savage natives. In corroboration of this opinion, it may be stated, that there are no less than four great military roads, leading to the city from different points, which are all evidently of Roman origin. Its central situation, as well as the fertility of the soil, and the beauty of the surrounding country, must naturally have suggested to those discriminating invaders its occupation as a military station. But not to dwell on apocryphal events and circumstances, faintly looming on the verge of authentic history, the first fact of any importance which emerges from its early annals is the charter granted by William the Lion, in 1210, and which raised it to the dignity of a royal burgh. It has been said, however, that Perth must have been a royal burgh in 1106, from the terms of a charter granted in that year by Edgar, in favour of one John Mercer, who in it is designated as a burgess of the city. In the charter of confirmation by James VI. allusion is also made to a previous one, granted by David I., who died in the year 1153. Perth enjoys the dignity of having been the ancient metropolis of Scotland. James II. was the first Scottish monarch crowned in Edinburgh, an event which happened in the year 1447; and soon afterwards the parliament and courts of justice were removed thither; but it was not until 1482, in the reign of James III., that Edinburgh was declared to be the capital of Scotland, and the Scottish court finally removed from the city of St John.

Perth appears to have been early fortified. From its importance as the seat of government, its central situation, and its vicinity to the Highlands, some defence was absolutely necessary. In these rude ages it was surrounded by the feudal castles of several powerful barons, with some of whom the inhabitants appear to have been frequently at feud, whilst with others, as Chartres of Kinfauns, the Earl of Gowrie, the Earl of Atholl, Lord Scone, and Threipland of Fingask, they were on such friendly terms as to have had one of their number for chief magistrate. Amusing evidence is to be found in the records of the burgh, of these alternate feuds and fraternizations. The worthy burgesses seem to have been men of mettle in those days, and on various occasions sallying forth from behind their walls, set fire to the castles of their haughty neighbours, when the latter, probably in reprisal for some offence, had forbidden their vassals to carry provisions to the city. In the year 1311, Robert Bruce laid siege to the town, but was obliged to withdraw his troops, after various unsuccessful attempts to take it. Not discouraged, however, the Scottish hero, having selected a band of determined men, and chosen a dark night, led them on in person, scaled the walls, and carried the town, sword in hand, the king himself being the second man who entered the place. About the beginning of the fourteenth century, the famous combat between the Clan Chattan and the Clan Quhele or Clan Kay, took place on the North Inch, and was decided in favour of the former, partly by the bravery of a citizen or burgess called Harry Wynd, whom the chief of the Clan Chattan had engaged on the spot to supply the place of one of his men who had failed to appear. The particulars of this singular conflict have been described by Sir Walter Scott in the first series of his Tales of a Grandfather; and in his romance of the Fair Maid of Perth, he has, with equal skill and effect, availed himself of the traditional story, which he has embellished with the felicity peculiar to his rich and inventive genius. This city has also been the scene of several of those social tragedies, in which the history of Scotland, in those rude times, was so prolific. In the year 1336, King Edward III. of England stabbed his brother the Duke of Cornwall, before the high altar of the church of St John; and in 1437, James I. was murdered in the monastery of the Blackfriars, with circumstances of the most savage barbarity. The murderers were executed in Perth, and the details of their punishment are of the most revolting character, reflecting but little honour on the good feeling and humanity of our forefathers. Perth appears to have been several times visited by the plague, particularly in 1512, 1585, 1608, and 1645. Its ravages during the last of these visitations were severe, three thousand persons having become its victims. In 1617, James VI. honoured the ancient capital of Scotland with a visit, the details of which, as found in the burgh records, are not a little graphic and entertaining. And in 1623, one of those exhibitions, of which James was so fond, and which leave a stain upon the national annals, took place in Perth; we mean, the burning of three poor women for witchcraft. In 1633, Charles I., in his tour through Scotland, visited Perth; and in 1651, Oliver Cromwell took military possession of the city, and erected a citadel on the South Inch. In 1559 John Knox appeared in Perth, and the excitement produced by his preaching, with the imprudent conduct of the Catholic clergy, caused the destruction of the finest ecclesiastical buildings in the city. Previously to the Reformation, Perth was crowded with religious houses, the cowled inmates of which swarmed in the city like bees. Many of these houses were buildings distinguished for elegance and taste, and the destruction of them is therefore much to be regretted. But the fury of the inhabitants was, in a great measure, confined to the edifices, which they were taught by their new instructors to regard as the abodes of iniquity; and hence, whilst they pulled down "the nests that the rooks might be scattered," they offered little personal insult to any one, and not a single Roman Catholic was put to death. The men of Perth, however, were zealously devoted to the cause of the Reformation. Three hundred of their number, bedecked with "St Johnston ribands," set out from the city, determined to prosecute the work of reformation, or to perish in the attempt. Before they reached Stirling, their numbers had increased to five thousand; and by the appearance of this faithful band, the struggle between the queen and the reformers was speedily brought to an end without the effusion of blood. The year 1600 was rendered memorable by the occurrence of the famous Gowrie conspiracy, as it is called; one of those events on which ingenuity and research have exhausted themselves in vain, and which, in its origin and circumstances, still remains enveloped in impenetrable mystery.

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[1] Lord Hailes informs us, in his Annals, that he had been favoured with various etymologies of the name, but not knowing which to choose, he had omitted them all. We learn from Fordun, however, that the town was formerly called *Bertha*, which is probably the Celtic *Bhar-tatha*, signifying the height of Tay, or Kinnoull Hill, immediately contiguous to the town; and this conjecture is strengthened by the circumstance that the word *Tatha* in Celtic is pronounced as *Ta* or *Tay* in English; so that *Bertha* is very nearly the exact sound of *Bhar-tatha*. But as the mutes B and P are interchangeable in Celtic, the one being used indiscriminately for the other, *Bertha* was shortened into *Berth* or *Perth*, in the ordinary course of human speech. It may be added, that the names of many places in the neighbourhood, as well as all over Scotland, are of Celtic origin, and that the vernacular language of the people not many miles from Perth still continues to be a dialect of that original language.

The present level of the city has been ascertained to be higher than it was at one period, and the level of the river appears also to have risen along with it, to the great injury of the navigation; vessels of considerable burden formerly discharging their cargoes farther up than they can do at present. The burgh of Perth is invested with an ample jurisdiction over the river, but does not appear to have paid much attention to the improvement of the navigation. Of late years, however, the subject has excited considerable interest; and, in 1834, the town-council obtained an act for deepening the river, and constructing a tide harbour and wet-dock. A powerful steam dredging-vessel has for some time been in operation on the river, and such have been its effects, that vessels of 200 tons, it is expected, will be soon able to discharge their cargoes at Perth. The city has also lately obtained the privilege of bonded warehouses, which will materially assist its foreign trade. The exports of the city, however, are comparatively but trifling; the accessible and thriving port of Dundee absorbing a great part of the foreign as well as coasting trade, which Perth formerly possessed. Potatoes constitute a considerable article of export to the London market, and the external commerce of the city may now be expected to improve, as the facilities of its river navigation increase. The imports are chiefly from the Baltic, and consist of flax, hemp, timber, seeds, cheese, and foreign spirits; coals, lime, salt, and manure, form the general coasting freights. In 1836, 736 vessels entered the harbour of Perth, the tonnage of which amounted to 40,000 tons. The capital vested in shipping is, however, but trifling. Between five and six thousand tons, in about eighty vessels of every description, comprise the shipping of the port of Perth. The salmon caught in the river form an item of some importance in its commerce, and are exported to London. The revenue of the burgh from its fisheries alone amounts to L.830 per annum.

A considerable quantity of cotton goods is manufactured in Perth, chiefly for Glasgow houses. The principal articles are ginghams, pullicates, umbrella-cloths, harness-muslins, and linen-lawns, employing about 1600 weavers. Calico printing and bleaching are carried on in the neighbourhood, to a very considerable extent. A large mill has lately been erected for spinning flax; and an establishment of this description has long been known as one of the best managed and most extensive in Scotland. There are, besides, three large founderies in operation, in which the manufacture of machinery and iron goods is considerable. But Perth appears to have rather retrograded as a seat of trade and commerce, as the early records of the burgh show that it formerly carried on an extensive traffic with the Baltic, the Mediterranean, and the Netherlands; the decay of which arose most probably from the increasing obstructions to the navigation of the river, by the gradual elevation of its bed from the accumulation of alluvial deposit, and from other incidental causes. The tanning of leather and the manufacture of gloves were at one time extensively carried on in Perth, but these trades have now greatly fallen off. About forty years ago, the printing of books was also a trade of some importance, but it is now of little consequence. Of late years ship-building has also been carried on to some extent. From the eligibility of its situation, the cheapness of living, and the low price of education of the best description, many respectable families in easy circumstances make Perth their residence.

The government of the city is vested in a lord provost, who is also sheriff and coroner, four bailies, a treasurer, the dean of guild, who is *ex officio* a member of the council, and nineteen councillors. There are two city clerks, a procurator fiscal, and a chamberlain. The city sends a member to parliament; and, in 1837, the constituency amounted to 1073. The burgh has a very large property and revenue, the former derived chiefly from the favour and munificence of several of the Scottish sovereigns. The property is estimated at L.67,510. 11s. 10d. and the revenue for 1836–1837 was L.6334. 8s. The debt of the city amounts to L.33,723, and the expenditure to L.5926. 11s. 7d. After Edinburgh was constituted the capital of the kingdom, Perth stood second on the roll of burghs of the Scottish parliament, and is still entitled to hold that rank. Its chief magistrate has for centuries enjoyed the title of lord provost; and by a judgment of the Court of Session (12th March 1836), he is still entitled to that distinction. The Circuit Court of Justiciary is held here twice a year, when the criminal offences committed in the counties of Perth, Fife, and Forfar are tried. At the spring court of 1838 the cases brought to trial were upwards of fifty in number, and although few of them were of great turpitude, the court were occupied during five days in disposing of them.

In the year 1831 the population of Perth amounted to 20,016 persons, but by a census recently taken, it is at present only 19,601, being 415 less than it was in 1831. The causes of this decrease are not easily ascertainable. Of the population, 11,683 have been stated as connected with the established church, and the rest are dissenters. In 1831 there were 2049 inhabited houses, containing 4956 families. Of public buildings, the principal are the bridge over the Tay, the barracks, the dépôt built for the reception of French prisoners during the war, St Paul's Church, the building erected to the memory of Provost Marshall, which contains a public library and the museum of the Literary and Antiquarian Society, the Perth Academy, the water-works, and the county buildings, a large and tasteful structure, situated close to the bank of the river. The lunatic asylum, an elegant building, is situated on the hill of Kinnoull; and an infirmary is almost finished. Besides these public buildings, several handsome streets have of late years been erected, which, combined with the natural beauty of the situation, render Perth one of the most desirable places of residence in this country. The town is well supplied with water, filtered from the river by a very ingenious method; and it is also well lighted with gas, by a company established for the purpose. The assessment for water cannot exceed five per cent. on the rental. The revenue of the post-office is about L.4000.

The Perth Academy, instituted in the year 1760, enjoys a high reputation as a seminary of classical and scientific learning. There are thirty-five schools in Perth, including the Academy. In the year 1834 the town-council applied to government for a grant, which, assisted by private subscriptions, has provided accommodation for 400 additional scholars. In 1697 a proposal was made to remove the University of St Andrews to Perth. The inhabitants have established several religious and charitable societies; and also a literary and antiquarian society of some note, which has a museum and library attached to it. A savings-bank was likewise established in 1815, the accumulated deposits of which, from that time till 1836, amounted to L.3188. 13s. 10d., whilst the sum lodged during 1836 exceeded L.381. In 1836 the assessment for the poor was L.2128. 13s. 3d. which was raised by a five per cent. tax upon rental, and L.723. 5s. 2½d. were collected at the church doors; besides which, the incorporated trades expend annually above L.2000 for the relief of their poor members. The poor's-funds obtained from the hospital of King James average yearly about L.435; and there are two other mortifications for their behoof, which realise annually L.312. 10s.; so that, not to mention various charitable societies, the interests of the poor are apparently well attended to in this ancient city.

PERTHSHIRE, one of the most extensive and beautiful counties in Scotland, being very compact and almost circular in form, is situated nearly in the centre of the kingdom. Its extreme length from east to west is about seventy-seven miles, and its greatest breadth from north to south is about sixty-eight miles. Its area has been variously estimated; but the nearest approximation to accuracy gives 2588 square miles of land and more than fifty of water. Of the 1,656,320 acres forming its superficial contents, from 500,000 to 600,000 are, according to the most recent statements, under cultivation; as many more are still uncultivated, though capable in part of tillage; and the remainder is almost wholly barren and unproductive. On the east Perthshire is bounded by the counties of Forfar, Fife, and Kinross; on the north, by Inverness and Aberdeen; on the south, by Stirling and Clackmannan; and on the west, by the shires of Argyle and Dumbarton. Its ancient and still popularly known divisions are Monteith, Athole, Strathearn, Breadalbane, Rannoch, Stormont, Perth proper, and Gowrie, to which some add Balquhidder and Glenorchy. It is under the jurisdiction of a sheriff and two substitutes, one of whom resides at Perth, and the other at Dumblane. There are within its boundaries seventy-eight parishes, or portions of parishes, some of them running into other adjacent counties.

Perthshire is distinguished amongst the counties of Scotland for the rich, varied, and picturesque beauty of its surface. From the commanding range of the Grampians, and numerous other secondary elevations, the country slopes gently down into extensive tracts of rich and fertile land, beautifully diversified, and adorned with wood and water, hill and dale, in every possible combination. Where the elevated ranges gradually disappear in the champaign country, nothing can exceed the rich and undulating character of the scenery, broken into noble and irregular valleys, or spreading out into extensive alluvial tracts, watered by streams of almost every size and character. The county of Perth is now generally divided into the highland and lowland divisions, the surface of the former being far more extensive than that of the latter. The fertile or lowland districts are chiefly, but by no means entirely, situated towards the eastern and the southern boundaries of the county. The fine valley of Strathearn, having the Grampian range on the north-west, with the Ochils and Sidlaw hills on the east, traverses it from north-east to south-west, and, including certain portions of the contiguous valleys of the Tay and the Almond, forms one of the richest and most extensive tracts in the kingdom. Besides the extensive valley of Strathearn, there are others of considerable dimensions, studded with lakes, and enlivened with streams of every variety of character. Such are those of the Tay, the Isla, and the Almond, and the valley of the Tummel, with its clear, soft, and beautiful lake, richly fringed on the margin with wood of various kinds, rising boldly up on the south, into the steep ridges of Schehallion and Faragon. Glenlyon and the valley of the Brann are not less rich and beautiful; and there are many others scarcely inferior to these in size and picturesque variety of scenery.

Perthshire is distinguished for its noble ranges of mountains, as well as for the great elevation to which some of them attain. The highest is Benlawers, 4015 feet: Benmore is 3903; Cairn Gower, 3690; and Schehallion, 3564. This last mountain is distinguished by its fine conoidal outline, as well as for being the spot selected by Dr Maskelyne for making his experiments to determine the density of the earth. Benledi rises to the height of 3550 feet; Ben Ardlanach to that of 3500; and Ben Venu to that of 3000; besides many others of considerable though inferior altitude. The principal lake is Loch Tay, fifteen miles in length, and about two at its greatest breadth. The outline of this fine lake is somewhat deficient in beauty, from the nearly straight and rigid character of its shores, particularly on the north side. At Killin and Taymouth, however, the scenery is varied and noble, presenting ample materials to the pencil of the artist. Loch Ericht is about sixteen miles in length, but half of it is included in the county of Inverness. The country around it is bare, wild, and devoid of interest. Loch Rannoch, which is nearly twelve miles in length from east to west, exhibits greater variety of outline, and its banks are agreeably diversified with old birches, the remnants of the once extensive forest of Rannoch. The finest view of Schehallion is obtained from the northern bank of this lake, at a point about four miles above Kinloch Rannoch. Viewed from the spot in question, the mountain presents a figure nearly conical, appearing to rise out of the lower extremity of the loch, and showing, in contrast with the water, one of the most magnificent natural objects to be seen in this or in any other country. Loch Earn, about six or seven miles in length, is a beautiful lake, with a richly-wooded, and in many places a highly-cultivated, but narrow strip of margin, from which the hills ascend rapidly and steeply. On the south-west there is the noble chain of lakes, Loch Ketterin, Loch Achray, and Loch Vennachar, which discharge their waters into the Forth. The scenery of these lakes is so well known as the locality of Sir Walter Scott's poetical romance, the Lady of the Lake, that it is unnecessary to describe its peculiar features. They are of the most varied and striking kind, such indeed as require to be seen in order to be fully appreciated; and the pencil rather than the pen must be employed to convey to those who have not beheld them a just conception of their mingled beauty, wildness, and magnificence. Divided from these by a ridge of elevated hills, we find Loch Ard, Upper and Lower, and Loch Con, from which the Forth takes his rise. The well-known lake of Monteith is in the vicinity of the latter. There are many other lakes, such as Loch Tummel, Loch Garry, Loch Voil, and Loch Lubnaig, all of some extent, and some of them rich in picturesque beauty of situation and outline. In the eastern quarter of the county is to be found another chain of lakes extending from near Dunkeld towards Blairgowrie, which are less known than they deserve to be. These are the three lochs of the Lowes, Marly, and Clunie. An old mansion on the loch of Clunie is said to have been the birthplace of the admirable Crichton.

The rivers of Perthshire are, the Tay, the largest stream in Scotland, with a course about ninety miles in length; the Isla, with its tributary the Ericht; and the Earn. The Tay and the Earn belong exclusively to this county, their entire course being confined to it; the Isla in the early part of its course sweeps through the western part of Forfarshire. The Tay is considered to discharge more water into the sea than any other river in Great Britain; the basin which it drains not only being very extensive in itself, and the seat of elevated mountain ranges, but abounding in streams of considerable magnitude, the principal of which it absorbs in its progress towards the German Ocean. Of those minor streams, which augment the volume of the Tay, the chief are the Lyon, the Almond, the Isla, the Brann, the Garry, and the Tummel. Throughout a considerable part of its course the scenery on the banks of the Tay is of the grandest and most impressive character; particularly in the upper part of its course, from Loch Tay, through the strath which takes its name from the river, to the pass of Birnam, where its banks become more level, and the country around assumes a softer character. But what is lost in boldness and grandeur is fully compensated by the rich and varied beauties of a wooded and cultivated soil, enriched with noble seats and stately mansions. The Earn passes through a rich and picturesque country; in some places bold and alpine in its character, and in others abounding in the mellow beauties of cultivation. On its banks, not far from its confluence with the Frith of Tay, stands the village of Pitcaithley, celebrated for its mineral waters, and now a favourite resort of fashionable valetudinarians. The Tummel is one of the finest rivers in Scotland, and is especially rich in wild and romantic scenery, from its source in Loch Rannoch, to its confluence with the Tay, immediately below the village of Logierait. The Earn and the Lyon, the Almond, the Brann, and the Airdle, besides other smaller streams, we can only afford to notice generally. They all partake more or less of the character of the fine districts which they traverse; imparting life and animation to many a mountain solitude, besides draining and watering extensive tracts of country.

Of the temperature of a region differing so much in exposure and elevation, nothing certain can safely be affirmed. In the upper and more elevated districts, where the mountain ranges slope down into the level country, and amongst the numerous glens which penetrate these in all directions, the climate is charged with moisture in a higher degree, the winters are longer and more severe, the snow frequently lies longer on the ground, and the spring is generally later than in the lower districts of the county. The highest summer temperature rarely exceeds sixty-five degrees, and the mean temperature, in three different situations in the county (none of them, however, more than 150 feet above the sea), has been found to be forty-seven degrees. The cloudy character of the atmosphere in the mountainous districts, by excluding the light of the sun, retards the ripening of the crops, and accumulates moisture, which tends to lower the average temperature. The district of Perth proper is said to be the least humid, the average water being only twenty-three inches; but in the Carse of Gowrie, on the shores of the Frith of Tay, the mean quantity of rain for twelve years was twenty-four inches and a half; at Perth, for a period of sixteen years, it was 26·95 inches; and at Belmont, in Strathmore, for thirty years, it was as high as 30·40 inches. The extensive drainage, executed of late years by various proprietors, has no doubt tended considerably to ameliorate the climate.

As far as is yet known, the minerals of Perthshire, in a commercial or economical point of view, are of no great public importance. Abundance of coal is to be found at Culross on the Forth, where it has long been wrought; but the situation renders it of no use to the inland and higher districts. Limestone is plentiful, and is wrought in considerable quantities; but for want of proper fuel it is not so generally used as it would be, peat, the only fuel in the upper districts, not being strong enough for the purpose of calcination. Lord Willoughby d'Eresby and Sir Niel Menzies have, however, lately devoted their attention to the compression of peat; and the results which they have obtained encourage the hope that that species of fuel may yet be rendered available to the improvement of the barren districts in which it abounds. Marble of a pretty good quality is found in Glentilt, and is now becoming an article of some importance in commerce. Slate is wrought in various places, particularly in the neighbourhood of Dunkeld; ironstone is found on the Devon, where it supplies the extensive iron-works established there; and copper and lead mines are said to have been at one time in operation, but have long since been abandoned. On the east side of the county shell-marl is plentiful, and is freely used as a manure. In the higher districts the general basis is granite, but in the lower sandstone prevails. The sandstone, which is of the primitive kind, stretches from the valley of Strathmore to the neighbourhood of Callander, with a dip varying from 15° to 25° towards the north-west. It seems to have received this position from the action of the central force which elevated the range of trap hills traversing the island from Montrose to Dumbarton.

In a county of so great extent, and possessing such a variety of surface, considerable diversity must exist in the character of the soil. The carse or alluvial lands on the shores of the Frith of Tay have long been celebrated for their fertility. They are considered as the joint produce of river and sea deposition for a series of ages. The general character of the soil is that of a rich clay, very deep, in some places alternating with layers of peat, and having sand and marine deposits at the bottom. This soil is not wholly alluvial, being sometimes mixed with the debris of trap-rocks, and also of the sandstone, which, as already mentioned, forms a geological characteristic of the lowland districts of Perthshire. Considerable tracts of this inferior description of alluvial soil are found accompanying the courses of the principal rivers, and extend into the upper portions of Strath-Tay, Strath-Airdle, and Strath-Tummel. A soil composed of clay and sand, and called by agriculturists a *till*, extends along a vast tract of this county from east to west, and is supposed to be formed from the red sandstone prevalent in that district. Peat is to be met with almost everywhere in Perthshire; that known by the name of *Moss Flanders* is said to extend over ten thousand acres, and is amongst the largest continuous tracts of this description in the united kingdom.

In the arable districts of this county, such as the Carse of Gowrie, and the fertile lands skirting part of the course of its principal rivers, the modes of agriculture and management of farms are much the same as in the other agricultural counties of Scotland. But of late years a spirit of improvement has been introduced, which has been much felt in this county, chiefly in the upper districts, where the old "runrig" system long kept its ground tenaciously, under the modified form of joint farms. The arable farms vary in extent from fifty to five hundred acres, and upwards; and in the Carse of Gowrie the rents are as high as in any part of the kingdom. Wheat is raised on the best soils, and has been attempted, not unsuccessfully, as high up in the county as Dunkeld. In the wheat-growing soils this crop usually alternates with beans and peas, barley, hay, and oats. Flax is more extensively raised in Perthshire than in any other part of Scotland, arising most probably from its being the raw material of the indigenous manufacture of the county. Potatoes and turnips are extensively cultivated, and of late years on the most improved methods. The pasture-farms in the higher parts of the county are large, and raise great numbers of sheep, chiefly of the black-faced kind. Other descriptions of live stock are not so much cultivated. Dairy farming does not form a prominent feature in the rural economy of this county. In some favoured spots orchards succeed well, many of them are very large, and their produce is highly celebrated. Perthshire is remarkable for the great extent and beauty of its woods. Of these, many are of natural wood, chiefly oak. But extensive plantations of various kinds of trees have been made during the last fifty years by several proprietors, especially by the late Duke of Atholl, whose planting operations have been carried on upon the most extensive scale, at once beautifying and enriching one of the finest parts of the county. To him Perthshire is indebted for the introduction of the larch, which has been found singularly adapted to the climate and soil. The plantations of this tree have thriven amazingly, and are of great extent and value. Larch has been used in ship-building, instead of oak; but their relative value for such a purpose is not yet fully ascertained. In 1674 the valued rental of Perthshire was L.339,892 Scots; and in 1815 the annual value of assessed property amounted to L.555,552 sterling.

This county is particularly rich in splendid seats and mansions belonging to the great proprietors. Of these, the most remarkable are Dunira, Taymouth Castle, Dunkeld House, the Palace of Scone, Kinfauns Castle, Murthly House, Dupplin Castle, and Blair Castle. Castle Huntly and Blair Castle are fine specimens of the old baronial and castellated habitations of the ancient lords of the soil; and Doune Castle is considered as one of the finest ruins of its kind in Scotland. Perthshire is not remarkable for antiquities, secular or ecclesiastical. Druidical circles and Roman remains are found in various places. Of the former, one circle almost entire, called by the country people Standing Stanes, formerly existed at Craigmakerran, the property, we believe, of the guildry of Perth; but about twenty-five years ago it was barbarously destroyed, and the stones blasted for the purpose of being employed in the erection of a farm-steading. Before this act of Vandalism was committed, the circle in question, which stood on a projecting crag, about six miles from Perth, on the Isla road, was perhaps one of the most perfect of the kind in the kingdom. Of the latter, the camp or station at Ardoch, and that at Comrie, are well known, as well as the Roman road, which seems to have connected them. There is another at Delvin, which is scarcely less remarkable. The ruins of the cathedrals of Dunblane and Dunkeld are also in excellent preservation, though the architecture is by no means of the highest order. The tower of Abernethy, which has long puzzled the heads of antiquaries, is unfortunately decaying rapidly, as is also the fine old abbey of Culross.

Red deer are still numerous in Perthshire, and impart a feature of peculiar interest to its forest scenery. The deer-forest of Athole is said to contain 80,000 acres; and the number of the deer in the whole county is estimated at 6000, of which about 100 are annually killed. Harts are destroyed in the months of August and September, and hinds in January, the last month of the season. From several of the large proprietors having combined to preserve the deer, it is considered that their number must be greatly upon the increase. Feathered game of every description abounds in the upland district of Perthshire, and affords a rich treat to the sportsman. Many of the moors are let to sportsmen, and bring large sums annually. Salmon is amazingly plentiful, especially in the Tay, and is also found in the tributaries of that river. The fisheries on the Tay alone are understood to bring a rental of L.10,000 a year, and those on the Earn are likewise said to be productive. The export of salmon forms a considerable article of commerce, as is mentioned in the account of Perth.

The principal towns are Perth and Culross, which are royal burghs; Crieff, Callander, Kincardine, Doune, Comrie, Dunblane, Auchterarder, Dunkeld, and Blairgowrie. Of the latter class, the largest is Crieff, the population of which in 1831 amounted to nearly 5000. It is a chief seat of the linen manufacture, which is also the principal occupation of Blairgowrie and Auchterarder, with a population of about 3000 each. None of the other towns is very remarkable, if we except Comrie, which is celebrated for the frequency of earthquakes in its neighbourhood; Dunblane, for its mineral waters; and Doune, once a great Highland mart, for its manufactory of pistols. The villages are numerous, and many of them populous and thriving; but it is unnecessary to particularize them. The greater part of Coupar Angus is included in the county of Perth.

The manufacture of linen, as already mentioned, is the staple manufacture of Perthshire; but cotton goods are also produced to a considerable extent. Mills for spinning flax, bleachfields, and calico-printfields, are numerous; and there are some large establishments for spinning cotton-yarn at Stanley near Perth, and at Danston. Paper is likewise manufactured to a considerable extent; and oil-mills are to be found in various places. A great many shoes are made in Perth, and the tanning of leather is carried on to a considerable extent at Crieff and at Thornhill. Of agricultural produce, large quantities of sheep and black cattle from the upper districts are brought to the country markets and sold there. Wool is likewise an article of considerable sale. From the more fertile districts large quantities of grain are annually brought to market. Bark and timber, principally larch and oak, also form commercial articles of no small importance. The produce of its fisheries has already been noticed as being amongst the list of exports. Limestone, slate, freestone, marl, and marble, from the fine quarries of Glentilt, are also brought to market, although, from the difficulty of transport, to a much less extent than they would otherwise be done.

In a word, the leading characteristics of this noble county are the variety and diversity of its scenery and productions, and the picturesque manner in which these are frequently grouped together. Fertility and barrenness, the wildest alpine magnificence, and the most delicious scenes upon which the eye of the lover of natural beauty could desire to rest; the rugged mountain towering in rude majesty, and the sweet glen enlivened with sunshine or curtained with mist; the rich alluvial plains of England contrasting with the glories of Switzerland in a more softened and subdued form; these are the general and prominent features by which it is distinguished. To the tourist it presents attractions of almost every kind. It is a sort of shifting diorama, in which new scenes remarkable for new beauties continually present themselves to his view, leaving upon his mind the impression that the last is, in some respects, the finest he has yet beheld. To the sportsman it opens a boundless field of amusement in its beautiful streams and its extensive moors, where the grouse, undeterred by the deadly hostility of man, renew their race but only to invite renewed destruction. In this county the naturalist has still much to explore; and after all the labours of Lord Webb Seymour, Professor Playfair, and some others, Glentilt alone would occupy a generation of mineralogists and geologists. In a word, this county, rich in every kind of natural beauty, and possessing many localities which have a deep historical interest attached to them, is not undeserving of the preeminence which has, by universal consent, been assigned to it, and merits a far larger share of attention than in the present article we have been able to bestow upon it.

The population of the county of Perth, in 1831, amounted to 142,894 persons, being an increase since 1821 of only 3844. The number of families was 31,749, and that of inhabited houses 23,809. Of the relative numbers employed in trade and agriculture we have no recent returns. The county sends a member to parliament, as does also Perth, the principal city. Culross, Queensferry, Dunfermline, Inverkeithing, and Stirling, unite in returning a third. The only change affecting this county made by the reform act, was enfranchising the city of Perth, which previously had only a fraction of a representative.

PERTINAX, an illustrious Roman emperor, who succeeded the detested Commodus. He was descended of a mean family, and, like his father, who was either a slave or the son of a manumitted slave, he for some time followed the humble employment of drying wood and making charcoal. His poverty did not, however, prevent him from receiving a liberal education. For some time he was employed in teaching a number of pupils the Greek and the Roman languages in Etruria. But having left this laborious profession, he became a soldier, and by his valour and intrepidity gradually rose to offices of the highest trust in the army, and for his services was made consul by M. Aurelius. He was afterwards entrusted with the government of Mœsia, and at length presided over the city of Rome as governor. When Commodus was murdered, Pertinax was universally chosen to succeed him in the imperial dignity; and his refusal, on the plea of old age and increasing infirmities, did not prevent his being saluted emperor and Augustus. He complied with reluctance; but his mildness, his economy, and his popularity, convinced the senate and the people of the prudence and the justice of their choice. He forbade his name to be inscribed on such places or estates as formed part of the imperial domains, and asserted that they belonged not to him but to the public. He melted all the silver statues which had been raised to his predecessor, and exposed to sale his concubines, horses, arms, and all the instruments of his pleasure and extravagance. With the money raised from these sources he enriched the empire, and was enabled to abolish all the taxes which Commodus had laid on the rivers, ports, and highways, throughout the empire. These patriotic actions gained him the affection of the worthiest and most discerning of his subjects; but the extravagant, luxurious, and vicious, raised a loud clamour against him; and when the emperor attempted to introduce amongst the prætorian guards such discipline as was absolutely necessary to preserve the peace and tranquillity of Rome, the flames of rebellion were kindled, and the minds of the soldiers completely alienated. Pertinax was apprized of their mutiny, but refused to fly at the hour of danger. Disregarding the advice of such of his friends as wished him to withdraw from the impending storm, he unexpectedly appeared before the seditious troops, and, without fear or concern, boldly asked them whether they who were bound by duty to defend the person of their prince and emperor, were come to betray him and to shed his blood? His undaunted courage and intrepidity would have had the desired effect, and the soldiers had begun to retire, when one of the most seditious of them advanced, and darted his javelin at the emperor's breast, exclaiming, "The soldiers send you this." The rest instantly followed the example; and Pertinax, muffling up his head, and calling upon Jupiter to avenge his death, remained unmoved, and was immediately despatched. His head was cut off and carried in triumph to the camp upon the point of a spear. This abominable murder happened in the 103d year of the Christian era.

It was no sooner known that Pertinax had been murdered, than the enraged populace flocked from all quarters of the city, and, uttering dreadful menaces against the authors of his death, ran up and down the streets in quest of them. The senators were no less concerned for his death than the people, probably because they were now convinced that the soldiers would suffer none but tyrants to reign. However, as they had more to lose than the common people, they did not offer to revenge his death, but either shut themselves up in their own houses, or in those of the soldiers of their acquaintance. Such was the unfortunate and lamented end of Publius Helvius Pertinax, after he had lived sixty-six years, seven months, and twenty-six or twenty-eight days; and reigned, according to Dio Cassius, eighty-seven days, that is, from the 1st of January to the 28th of March. His body, together with his head, was interred with great pomp by Didius Julianus, his successor, in the burying-place of his wife's family. Septimius Severus, with the title of emperor, assumed the name of Pertinax, which he knew would, above any thing else, recommend him to the army in Illyricum, and to the Roman people. He punished with great severity all those who had been accessory to his death; disbanded the prætorian guards; honoured his memory with a most magnificent funeral, at which was carried the effigies of the deceased prince; pronounced his panegyric, and caused him to be ranked in the number of the gods, appointing the son chief priest to his father. The day of his accession to the empire was yearly celebrated with the Circensian games, and his birth-day, for many years afterwards, with other sports. He performed great things, says Herodian, during his short administration, and would have restored the empire to its former lustre, had he been indulged with a longer reign.

PERTUIS, a city of France, in the department of Vaucluse, and arrondissement of Apt. It is situated on the river Air, about three miles from its junction with the Durance, and contains about 540 houses, with 4280 inhabitants, who are chiefly employed in spinning and weaving silk, and in the distillation of brandy. Long. 5. 30. E. Lat. 43. 44. N.

PERU.

Peru is the name of one of the republics of South America, but it likewise designates a large empire long since dismembered, yet still renowned for its wealth and ancient civilization. The limits of the present state do not comprehend much more than one third of the country over which the incas held dominion, from its having been repeatedly partitioned by the Spaniards, and always unwisely even for themselves. Ancient Peru extended from about 2. 0. of north to the twenty-sixth parallel of south latitude, thus including what is now called the Republic of the Equator, or Quito; and from 57. 0. to 81. 0. of west longitude, thus comprehending the whole of Bolivia or Upper Peru. Previously, however, to defining the boundaries of the republic, and describing its present condition, we shall briefly glance at the early annals of the country, and then take a rapid historical survey of the political revolutions which it has undergone, from the period when the Spaniards first drew their swords upon the "Children of the Sun."

The native annals of Peru ascend no higher than the era of the first inca, who flourished in the twelfth century. The individual who first established monarchical authority in the country was called Manco Capac, supposed by the natives to have been commissioned by divine Providence to deliver the world from an evil genius, to whose diabolical sway it had been abandoned. From this superstition, and also from tradition, it appears that previously to the period in question, the inhabitants of Peru ranked amongst the most barbarous of the American savages, roaming the primeval forests with which their country was then covered, more like wild beasts than men, strangers to agriculture and to all the useful arts, and having no fixed place of abode. Manco Capac, however, along with the beautiful Mama Oello or Ocollo, at once his wife and sister, reclaimed the Peruvians from this degraded condition. He showed them how to till and irrigate the soil, to construct residences, and to fix the division of lands. He overthrew their altars which were stained with blood, and taught them the more harmless idolatry of worshipping the sun. Assisted by Oello, he instructed the people in the moralities of life and the obligations of nature; he enjoined every man to bestow a portion of his time and industry for the benefit of his neighbour, and inculcated brotherly love not only amongst members of the same, but of different families. He framed laws for the happiness of the community, and commanded obedience to them more by humanity than by force. At the same time he compelled his subjects to submit implicitly to the will of the incas, and retarded the progress of the human mind by making it unlawful for a son to follow any profession except that of his father. The empire which this remarkable person founded comprised only a small territory around the city of Cuzco; and the Peruvian traditions assign no earlier date than that of his reign to the dawn of civilization. It is the opinion of Humboldt, however, that the architectural monuments which are found on the elevated table-land of Tiahuanaco, had an origin prior to the twelfth century, and that they served as models for the edifices which the incas erected at Cuzco; thus proving, that remarkable advancement had been made in the useful arts before the time of Manco. Who the architects of these original structures really were, it is nearly impossible to conjecture, far less to assert with confidence. The Spaniards, on their arrival in the country, were informed by the natives that they were constructed by "a race of white and bearded men," who inhabited the ridge of the Cordilleras long before the foundation of the empire of the incas.

But to whatever race they may have belonged, it seems perfectly certain that they had found their way to Peru along the ridges of the Cordilleras, and that the civilization of South America, as well as that of Mexico, emanated from the north. The following observations of Humboldt, in reference to the appearance of Manco Capac, are characterized by his usual sagacity. "Though no traditions point out any direct connection between the nations of North and South America, their history is not the less fraught with analogies in the political and religious revolutions from which dates the civilization of the Aztecs, the Muyscas, and the Peruvians. Men with beards, and of fairer complexions than the natives of Anahuac, Cundinamara, and the elevated plain of Cuzco, make their appearance without any indication of the place of their birth, bearing the titles of high priests, legislators, the friends of peace and the arts, and operate a sudden change in the policy of the nations, who hail their arrival with veneration. Quetzalcoatl, Bochica, and Manco Capac, are the sacred names of these mysterious beings." Still this only refers to a second migration. Those to whom the natives attributed the construction of the more ancient works had arrived in the country long before the first inca came amongst them, no one knew from whence. But over the erection of these earliest architectural monuments there hangs a veil of impenetrable mystery.[1]

Under the sway of Manco and his successors the improvement of the barbarians of Peru advanced with amazing celerity; but it soon reached as high a point as the state of knowledge and the political circumstances of the country would admit. In Peru agriculture was carried on with greater skill than in any other part of America; and the monarchs themselves set an example of industry, by cultivating a field near Cuzco with their own hands; an honour which is still conferred upon agriculture in the "celestial empire." They showed much ingenuity in the building and navigation of their floats; but it was in the erection and ornamenting of their temples and palaces that the Peruvians displayed the utmost extent of their constructive skill. The ruins of these magnificent edifices, which are found in every province, attest at once the great power possessed by the early monarchs, and the high degree of knowledge in the arts to which the people had attained; whilst they also show that during two centuries at least the nation must have subsisted in a state of considerable improvement. The great temple of the sun at Pachacamac, with the palace of the inca, and the fortress, were so connected together as to form one great building half a league in circuit. But perhaps the noblest works of the incas were the two great roads from Cuzco to Quito, a distance of not less than 1500 miles. One of these was carried through the mountainous country, and the other wound along the maritime plains. At proper intervals storehouses were erected for the accommodation of the inca and his attendants in his progress through his dominions; and flying bridges of ropes were stretched across the torrents which intersected the road in their course from the Andes to the western ocean. Although these roads were only fifteen feet in breadth, and not fit for carriages, yet they must be considered very wonderful works, from the natural obstacles which had been overcome in constructing them. Mounds of earth and other works rendered the ascent of hills comparatively easy. Granaries were built at certain distances; and charitable houses, ever open to the wanderer, were founded by the incas. Canals, fortresses, and other buildings of a public nature, varied and improved the aspect of the country.

In many of the provinces, the sides of lofty hills, or rather mountains, are cased round with terraces or hanging gardens, which rise one above another to a surprising elevation. Each terrace is faced with stone, and although of inconsiderable width, they cover the sides of such high and extensive mountains, that they alone must have produced subsistence for a large population. These terraced strips of land were by the Peruvians called Andenes, which probably induced the conquerors to give the name of Andes to the whole of the gigantic mountain chain which stretches from the Straits of Magelhaens to the Isthmus of Panama. The Andenes are often to be seen in districts where rain never falls, and how they could have been irrigated is now unknown.[2] Amongst the remarkable works of the ancient Peruvians were the azequias or aqueducts, by which large tracts of country now condemned to perpetual sterility were made fertile by water conveyed from an immense distance. The subterraneous azequias of Nasca were of great extent; and although many of them are choked up, a sufficient number remain to give amazing fertility to the valley of Nasco. It is not known how far they penetrated, but it is supposed that the Peruvians drove an adit horizontally until they met with a perennial spring.

The skill of the ancient Peruvians in mining, metallurgy, and the working of the precious metals, was considerable, and beyond that of the other American nations. Not only were the sacred temples and the royal residences profusely adorned with ornaments of gold and silver, but even trees and shrubs fantastically formed of these metals were placed in the imperial gardens at Cuzco. The most ordinary domestic utensils were made of them; and several of their vessels and trinkets are said to have exhibited considerable skill in the workmanship. Mirrors of highly polished stone have been discovered in their sepulchral mounds; but that which gave the Peruvians a decided superiority, in various arts, over the other tribes of the west, was such a knowledge of metallurgy as enabled them to mix copper and tin in such proportions as to form a compound metal hard enough to supply the place of iron. But notwithstanding this advantage, they were lamentably deficient in all the implements necessary for the mechanical arts, and none of their attainments are entitled to be considered as greater than those of a people in the first stage of incipient civilization. The painting, statuary, and carving which adorned their temples and palaces appear to have been very indifferent. Humboldt remarks, that the Peruvians were not unacquainted with symbolical paintings, but that they had nothing at all equivalent to the picture-writing and hieroglyphics of the Mexicans. They made use of knots and threads of various colours, which they called *quippos;* and these strings were used to record events, as well as for purposes of calculation. Their knowledge of astronomy, although exceedingly imperfect, was yet far from being contemptible. The incas, who had discovered the annual revolution of the sun, marked out the summer and winter solstices by high towers, which they erected on the east and west of the city of Cuzco. By the position in which the sun rose and set on the east and west of these, the summer and winter solstices were determined. They also observed the equinoxes, and celebrated the event of the vertical position of the luminary in heaven, by holding a great festival in the temple which they had dedicated to it on earth. They distinguished the months by the moon, and their weeks were called quarters of the moon. Like other ignorant races of men, they were alarmed by eclipses of the sun or moon; but they do not appear to have predicted events by the aspect of the stars, though dreams, and the entrails of beasts, which they offered in sacrifice, were considered as instructive objects of divination.

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[1] See the Foreign Quarterly Review, No. 35; the article MEXICO in this work; and Humboldt's Researches, vols. i. and ii.

[2] Memoirs of General Millar, vol. ii. p. 188–9.

The government of the incas was a species of theocracy, the sovereign uniting in his own person the functions of priest and king, with both temporal and spiritual domination. The sun was the object of supreme adoration, and the incas were considered as his children, descended from him through Manco Capac, who was believed to be the offspring of their god. They also adored a twofold being named Con Pachacamac, who they believed was the creator of the Peruvians. But although the Peruvian form of government was the most absolute despotism, it was much more mild in its nature, and less oppressive in its operation, than that of the Mexicans. The people were taught, and they yielded, the most slavish submission to their sovereigns; for, after their deity the sun, the incas were regarded with the greatest veneration. Almost every crime was punishable with death; and the incas seldom forgave an injury. It was customary for them to mutilate the faces and limbs of all the individuals taken in a revolted district. As an illustration of the nature of their government, one law may be sufficient. If it were discovered that a priestess of the sun had violated her oath of chastity, she was buried alive, whilst her seducer was tortured to death in the most cruel manner. Even the families of the offending parties were consigned to the flames; and a line being drawn around the birthplace of the two lovers, like the doomed cities of Scripture, it was marked out as a desert for ever. The number of offenders against any of the laws is said to have been extremely few. Their religion, however, was unpolluted by the bloody rites of that of Mexico. The "terrible god," the Moloch of the west, held no sway in Peru. Lambs and other animals were offered in sacrifices, but human victims never bled on the altars of the sun. The national character of the Peruvians harmonized with the genius of their religion, being more gentle and pacific than that of any other people in America. Even their wars are said to have been prosecuted with singular humanity. But the funeral rites of their monarchs accorded ill with this mildness in religion and general manners. At the death of the incas and of other eminent persons, a number of their vassals were buried in the tumuli, along with the dead bodies. The number was sometimes very great. On the death of Huana Capac, the greatest of their incas, above a thousand victims were doomed to accompany him to the tomb. In another particular the manners of the Peruvians were singularly barbarous. Although very well acquainted with the uses of fire in culinary operations, they astonished the Spaniards by devouring both flesh and fish perfectly raw.

Gold and silver were used for ornamental purposes alone, and were never employed as a circulating medium. The produce of the earth was enjoyed in common. The whole being divided by proper officers into four portions, the first was destined for the indigent; the second was set apart for the maintenance of the priests and virgins of the sun, and for other religious purposes; the third was appropriated to the community; and the fourth and last to the inca and his family. The incas spoke a language which was not permitted to be taught even to the nobles, far less to the people; and messages were transmitted to members of his family, from one end of the kingdom to the other, without the bearers of them, who were stationed at regular intervals, understanding the import of the communication which they conveyed. This language was lost a generation or two after the conquest.

That Cuzco was the only city which ancient Peru possessed, as asserted by Dr Robertson, is completely at variance with the accounts of recent travellers, who have found extensive remains in various parts of the country. It was, however, the capital of the empire, and the centre of its wealth and civilization. Throughout the rest of Peru the people appear to have lived chiefly in detached habitations or small villages, with the exception, it may be hazarded, of a few large towns, situated widely apart and in particular positions; for it appears that the Peruvians never built a town or suffered a single house to occupy a spot that was susceptible of cultivation. Little intercourse was maintained amongst the different provinces, for there were no stated markets, as in Mexico, and the inland trade was insignificant. Distinction of ranks was recognised, for not a small proportion of the inhabitants were scarcely above the condition of slaves; but there was no separation of crafts, every Peruvian practising all the arts indiscriminately. That this people could have advanced far in improvement under such a system was impossible; and we are only surprised that they should have attained to such a degree of refinement as they actually reached. The natural character of the Peruvians was also such as to preclude anything like a rapid progress of manners and refinement of life. They were tame and abject; their mildness degenerated into sloth, and their submission into a slavish fear of danger. When all these circumstances are taken into consideration; the vast extent of country over which the inhabitants were scattered, chiefly in hamlets and huts, and having little intercourse with the imperial city; the physical weakness of the Indian race in general, and the natural timidity of the Peruvian character in particular, increased as it must have been by the system of government under which they lived; and the political debility which necessarily attached to a social structure so slenderly constituted as that of Peru; when these things are duly weighed, we shall experience less surprise that the conquest of the country should have been effected, almost without a struggle, by a handful of daring and desperate adventurers.

The first intelligence of the great Southern Ocean, and the country washed by its waters, was obtained by Nuñez de Balboa, Spanish governor of Darien, in 1512, and purely by accident. In one of their numerous inroads into the country adjacent to that in which they gained a permanent footing, a violent dispute arose amongst the Spaniards about the division of some gold. A young cacique or petty prince, who was present, astonished at their contention about a thing which was to him of little value, acquainted them with the existence of a country six suns to the south, where even the utensils in common use were made of the same metal as that about which they seemed ready to shed each other's blood. The eager cupidity of the Spaniards was roused by this welcome information, and no time was lost in preparing for the invasion of this land of gold. Balboa, accompanied by a hundred and ninety of his countrymen, and about a thousand Indians, commenced his journey across the isthmus, which, although only sixty miles in breadth, was so encumbered with natural obstacles, that five and twenty days were spent before he obtained a sight of the Southern Ocean, which he did from a mountain near Panama. The view of this vast expanse repaid the adventurers for their past toils and sufferings. They advanced to the shore with the utmost alacrity; and their leader, rushing up to the middle in the waves, with his sword and buckler, took possession of it in the name of the king his master. The part which he discovered is still designated the Gulf of St Michael, the name which he bestowed upon it. Balboa, however, did not reap the reward which he merited for this important discovery. By an ungrateful government he was superseded in his command; and although afterwards restored to high authority, he fell a victim to the jealousy of the individual with whom he was associated in the government.

For a short time after the death of Balboa, the thoughts of conquering Peru were laid aside; but a new expedition was at length set on foot, at the head of which appeared the famous, or rather infamous, Francisco Pizarro, a soldier of fortune, and formerly in the service of Balboa. Associated with him were Diego de Almagro, a man of as humble extraction as himself, and likewise a soldier of fortune, and Hernando de Luque, who combined the functions of priest and schoolmaster at Panama. Towards the close of 1524, Pizarro sailed from the port of Panama in a small vessel, with only a hundred and twelve followers, to undertake the subjugation of half the western world. We may smile at the disparity between the extent of the enterprise and the paucity of the means by which it was to be achieved, and feel astonished that it should ever have been attempted under such circumstances. But the Spaniards, naturally brave, courted danger, and were enamoured with the excitement of conquest. Exposure to peril had rendered them fearless, and a succession of triumphs had made them arrogant. The season at which Pizarro embarked was the most improper that could have been chosen; for the periodical winds which then began to blow were directly adverse to the course which he wished to steer. But after a series of disasters and disappointments, which he bore with a patience and fortitude worthy of any undertaking, and in defiance of a recall from the governor of Panama, he succeeded, in 1526, in reaching the coast of Peru. After touching at several villages, he landed at Tumbez, a place of some note, about three degrees south of the line, and remarkable for its stately temple and a palace of the incas. Here the golden dreams of the Spaniards were, if possible, more than realized. But for the present they could only feast their eyes on the vision of riches before them; for the force of Pizarro was far too limited to attempt the conquest of the opulent empire thus discovered; and towards the close of the third year from his departure this adventurer regained the port whence he had sailed.

Pizarro immediately repaired to the court of Spain, for the purpose of turning his discovery to advantage. The powers which he solicited were granted him. He was invested with supreme civil and military authority over the country to be conquered, his jurisdiction being declared to extend prospectively two hundred leagues to the southward of the river St Jago. The means of executing this commission he was left to provide entirely from his own resources, which were slender; but they proved sufficient. He returned to his confederates at Panama, and after exerting his utmost efforts, the whole armament which he was able to fit out amounted only to three small vessels, carrying a hundred and eighty soldiers, of whom thirty-six were mounted. His first descent was on the shores of St Matthew's Bay, whence he pursued his march southward along the coast, meeting with little or no resistance, and suffering no calamities except such as were inflicted by the insalubrity of the climate and the sterility of the soil. From first to last, the New World was conquered as much by the terror which the aspect and manners of the invaders inspired in the breasts of uncivilized men, as by force of arms; and the general impression made on the timid Peruvians proved irresistible and paralysing. But another cause contributed to the rapid success of Pizarro. At this very time the country was embroiled in a civil war. When the Spaniards first visited the coast of Peru, Huana Capac, the twelfth monarch from the founder of the state, was seated on the throne of the incas. By his victorious arms he had subjugated the kingdom of Quito; a conquest of such extent and importance as almost to double the power of the Peruvian empire. This prince is represented as alike conspicuous for his pacific virtues and for his abilities in war. He was, at all events, a bold innovator; for, in defiance of the fundamental law against polluting the blood of the children of the sun with any foreign alliance, he espoused the daughter of the conquered monarch; and by this princess he had a son named Atahualpa, commonly written Atabalipa, to whom he left the kingdom of Quito at his death, in the year 1529. To Huascar, his eldest son by a mother of the royal line, was bequeathed the rest of his dominions. This arrangement was productive of a civil war, in which the sovereign of Quito proved victorious; and, to place himself more firmly on the throne, he put to death all the descendants of Manco Capac whom he could seize either by force or stratagem. Huascar himself was a prisoner in his hands, but from political motives his life was spared. This unhappy contest completely diverted the attention of the Peruvians from the circumstance of a foreign invader having violated their soil. It was some time, however, before Pizarro gained information of the events which so opportunely conspired to forward his enterprise; indeed the first intelligence he received was the appearance in his camp of messengers from the rival sovereigns, each soliciting the fatal aid of their common enemy.

Pizarro, as sagacious as he was daring and unprincipled, perceived at once the importance of the intelligence, and the fortunate position in which the affairs of the country were placed for him and his cause. At the head of an ill-accoutred train of a hundred and two foot soldiers, of whom twenty-two were armed with cross-bows, and only three with muskets, and sixty-two mounted followers, he pushed forward from St Michael's, where, in May 1532, he had established the first Spanish colony in Peru. He directed his course towards Caxamarca, a town of the interior, distant twelve days' march, where Atabalipa was encamped with a considerable body of troops. Appearing in the guise of an ambassador, or rather pacificator, his professions were received with inconsiderate credulity; and the inca became the victim of the perfidy of the Spaniard. Relying with unsuspicious simplicity on the honour of the man whom he considered as his guest, Atabalipa consented to give him an audience in that part of the city where he and his followers had established themselves. In the mean time Pizarro had made every preparation for receiving the inca in a manner which he little expected. He arranged his troops in as advantageous a situation as possible, within a square wholly surrounded by a strong rampart or wall of earth; and there he awaited the emperor, who slowly approached with all the pomp of barbaric splendour. The latter was borne on the shoulders of his principal attendants, seated on a throne or couch, resplendent with plates of gold and silver, enriched with precious stones, and adorned with waving plumes of the most gorgeous hues. Behind him came the chief officers of his court, and bands of singers and dancers attended the cavalcade, whilst the Peruvian army, to the number of 30,000 men, swarmed all over the surrounding plain. With matchless perfidy Pizarro instructed a priest to inform Atabalipa, that the vicegerent on earth of the God whom they worshipped had made a donation of all the nations of the New World to the king of Castille, their master, and that he must accordingly surrender Peru. At the same time he was required to renounce the service of the sun, and become a convert to the religion of the Spaniards. Astonished at this extraordinary proposal, he asked the priest for a sight of his credentials; and a breviary being handed to him, he lifted it to his ear.

"This," said he, "is silent; it tells me nothing;" and he dashed it to the ground with disdain. The wily monk, who appears to have been exactly the tool which Pizarro wanted, ran towards his countrymen, calling out that the word of God had been insulted, and that they ought to take immediate vengeance on the impious dogs who were guilty of such a profanation. At once the signal for assault was given, and an indiscriminate massacre of the unresisting Peruvians took place. In vain did the wretched fugitives seek shelter from the avenging steel of the Spaniards. They were pursued even within the sanctuaries of their religion, and cut down around their altars with unrelenting barbarity. Atabalipa himself was taken prisoner, and put into close confinement. A proposal of the inca to ransom himself by paying an enormous quantity of gold was instantly caught at by Pizarro; and the devoted subjects of the captive king, with eager alacrity, obeyed his call to bring him their treasures in order to procure his liberty. Meanwhile, Almagro arrived with a reinforcement of Spaniards equal to that already in the country. The rapacious bravoes who composed it, being as yet unglutted with the spoil of the richest country in the world, urged Pizarro to put the inca to death, and thus clear the way for a thorough plunder of the whole empire. The chief of this banditti had himself previously determined on taking this step, and probably only waited for the proposal coming from the troops in order to carry it into execution. After performing a ceremony preparatory to execution (it would be an abuse of language to call it a trial), the Spaniards condemned the inca of Peru to be burned alive, which merciless sentence was, as a great favour, mitigated to strangling, and the unhappy victim suffered accordingly. Amongst a list of imaginary crimes which were laid to his charge, there was one of which he had really been guilty, namely, putting to death his brother Huascar. This cruel and unnecessary deed of blood he was induced to commit from fear lest, in his own helpless situation, his rival to the throne might join the invaders against him. But Spaniards were not competent to try him for such an act; he was only amenable to his own country; and the allegation was as irrelevant as the other parts of the charge in this solemn mockery of justice.

The murder of Atabalipa was soon followed by a revolution in the affairs of the Spaniards, whose barbarous inhumanity now rendered them odious to the Peruvians. Even amongst themselves were found a few persons not altogether divested of pity and a sense of justice; and the dread of impending danger from the Indians now uniting against Pizarro, alone restrained these soldiers within the bounds of discipline. At Cuzco, the partisans of Huascar elevated his brother Manco Capac to the throne of the incas, whilst Pizarro set up Taparpa, the son of Atabalipa, as emperor. But this prince was relieved by death from the degradation of being innocently accessary to the humiliation of his country. No other person having been invested by the Spaniards with the insignia of mock royalty, the title of Manco Capac was universally acknowledged. The attempts of the Indians, however, to arrest the progress of the invaders proved unavailing; but the latter quarrelled amongst themselves about the division of the spoil. Ferdinand Pizarro, the brother of the general, had been sent to the court of Spain to report the progress of spoliation, and to deposit a part of the booty. Honours were conferred upon him, and his brother obtained an additional grant of land, whilst he himself was invested with the jurisdiction of a very large tract of country lying still further to the southward. No sooner did Almagro hear this than he attempted to seize Cuzco, alleging that it lay within the limits of his government; and a civil war between his partisans and the Pizarro faction was only prevented by an accommodation, on the singular footing that Almagro should indemnify himself by attempting the conquest of Chili. This reconciliation left the general at liberty to settle the internal policy of his province. He divided the country into districts, over which magistrates were appointed to preside; and he removed the seat of government from Cuzco to Lima, which he named Ciudad des los Reyes. He likewise despatched some of his most distinguished officers to inspect those provinces of the empire hitherto unvisited by the Spaniards; but this imprudent feeling of security nearly proved fatal to him. The Peruvians, with Manco Capac at their head, seeing the Spaniards weakening themselves by dividing their force, seized the opportunity of making a desperate effort to avenge their wrongs and to rid themselves for ever of their oppressors. This insurrection took place in the year 1535–1536. The Spanish historians, probably to exalt the prowess of their countrymen, assert that an army of more than two hundred thousand men was collected, part of which invested Lima, where the governor was closely shut up, whilst a still larger body of men laid siege to Cuzco. Half of the city had already fallen into the hands of the Peruvians, and the besieged were reduced to the most desperate condition, when Almagro suddenly made his appearance in the neighbourhood. Upon his arrival, his assistance was solicited by both parties; but the inca, despairing of success in his negotiations with Spaniards, attacked Almagro during the night. Spanish valour and discipline, however, prevailed over the greatly superior numbers of the Indians, who were repulsed with terrible slaughter, and the governor of Chili advanced unopposed to the gates of Cuzco. Over the capital of the incas his authority was now fully recognised, though not without an affray, in which several Spaniards were killed. But very soon afterwards matters began to assume a serious aspect; in short, it now came to the issue of arms, whether Pizarro or Almagro should remain master of Peru. The latter was at first completely successful against the brothers of the general; but in an engagement with Pizarro himself he was defeated and taken prisoner. The conquerors behaved with a cruelty which struck horror into the minds of the barbarians, who had assembled out of curiosity to see the battle. Almagro, after languishing some months in prison, was at length formally tried and condemned to death; which sentence he underwent by being first strangled in private, and afterwards beheaded in public.

In the meanwhile intelligence having reached the court of Spain of the dissension which had taken place in Peru, the king appointed a new governor, who, on his arrival, was to assume the supreme command, provided Pizarro had fallen, which proved to be the case. Almagro left a son by an Indian woman, and this youth he appointed his successor, by virtue of a power granted him by the emperor. The partial division of the spoil which had been made by Pizarro and his brothers tended to alienate many of the Spaniards from their cause. Great numbers of the disaffected repaired to Lima, where the house of young Almagro was always open to receive them; and here a conspiracy was formed against the life of Pizarro, at the head of which was Juan de Herrada, an officer of distinguished abilities, and who had had the superintendence of Almagro's education. The natural intrepidity and fearless disposition of the general proved his ruin; for, utterly disregarding the warnings which were given him of approaching evil, he took no measures either to discover the plot or to protect his own person from violence. In this state of fancied security access to his palace was easily gained by the conspirators. On the 26th of June 1540, Herrara, with eighteen of the most determined of his followers, sallied from the house of Almagro, and advancing through the streets, shouted "Long live the king, but let the tyrant die." He entered the palace of Pizarro without opposition, and gained the apartment where his victim was conversing with some of his friends, having just risen from table. His resolute mind no form of danger could appal: he hastily snatched a sword and buckler, with which he maintained the unequal contest, in a manner worthy of his past exploits. But friend after friend was cut down at his side; and, no longer able to turn aside the numerous weapons so furiously aimed at his life, he received a deadly thrust in his throat, sunk to the ground, and expired. Thus perished by the swords of assassins Francisco Pizarro, the conqueror of Peru, a man who in mere valour was probably never surpassed; but whose injustice, rapacity, and cruelty rendered him unworthy of a better fate.

After the death of Pizarro, young Almagro was placed at the head of the government; but his career was short and troubled. The new viceroy having arrived from Spain, he refused to relinquish his pretensions, and a struggle ensued, which proved fatal to himself and all his followers. Another insurrection, however, broke out under Gonzales Pizarro, who had just returned from a most disastrous expedition into the country to the east of the Andes, and was thus prevented from taking any part in the revolutions which had so rapidly succeeded each other in Peru. To oppose this new aspirant to viceregal power, Nuñez Vela, governor of Lima, assembled a motley army of Indians and Spaniards; and, after various successes on both sides, a decisive battle was fought under the walls of Quito, in which Nuñez perished, along with the greater number of his followers. But another viceroy arrived from Europe in the person of the licentiate Pedro de la Gasca, and against him it was necessary for Gonzales to take the field. But many deserted his standard to rally round that of a person who was invested with a lawful authority to govern them; and those whom the tyranny of the usurper had driven to forests and caverns now quitted their hiding-places and joined the royalists. On the 9th of June 1548, an engagement took place near Cuzco, in which the last of the Pizarros, deserted by his followers, was taken prisoner, and afterwards beheaded. Such is the last event of any importance connected with a history, every line of which is written in blood. During these ferocious contentions, in which the rancour of enmity was rendered more intense by avarice, honour, the proverbial virtue of the Spaniard, was utterly disregarded. There was hardly one of them who did not abandon the party which he had originally espoused, and betray or desert his former associates. This is not to be wondered at when we reflect that most of the followers of Pizarro were needy adventurers, soldiers of fortune, exactly similar to those who had for centuries swarmed in various countries of Europe, and who sold their services to the best paymaster. The same mercenary principle appears to have been acted upon by the Spaniards in Peru; they attached themselves most tenaciously to the leader who held out the richest bribe. Petty insurrections continued to disturb the country for several years; and most of the first invaders, as well as a large proportion of the licentious soldiery whom the fame of their success had drawn thither, perished in their contests one with another. Ultimately the devoted land was thus cleared of those turbulent and desperate spirits which had been let loose upon it, and the royal authority was finally as completely established in Peru as in the other Spanish provinces.

The whole of the dominions of Spain in the New World were at first divided into two immense governments; one subject to the viceroy of Mexico, and the other to the viceroy of Peru. But the latter was, at two subsequent periods, reduced in order to give such extension to other provinces as should entitle them to the rank of viceroyalties. In the year 1718, the province, or, as it was sometimes called, the kingdom, of Quito, was detached from Peru, and added to the government of New Grenada. In the year 1778 the provinces of the Rio de la Plata, Potosi, Charcas, Chiquitos, and some others, were detached from the jurisdiction of the Peruvian viceroy, and erected into a separate government, of which Buenos Ayres was made the capital. To these four governments alone was attached the dignity of a viceroyalty. Guatemala, the provinces of Venezuela, Caraccas, Cumana, and Chili, were severally formed into distinct jurisdictions under a captain-general. Having already given a view of the colonial system of administration under which the Spanish territories in the New World groaned for nearly three centuries (see the article MEXICO), we shall only here advert to two distinct features of the tyranny which was exercised over the aborigines of Peru. These were the *mita* and the *repartimiento*. The former was a civil conscription, by which the population of every district was compelled to furnish annually a certain number of labourers for the service of the proprietors of the lands or mines. It is true that under the incas a great body of the natives were held in a state of degrading vassalage, so that a change of masters did not involve a change of condition in as far as mere labour was concerned; but the effects of being condemned to work in the mines for a fixed period proved most fatal to them. By the regulation, every Indian from the age of eighteen to fifty was pressed into the mining service for six months once in every three years and a half. On these occasions they were under the necessity of quitting their homes and families, relinquishing their professions, and repairing, it might be, many hundred miles to some inhospitable spot, where, it is said, scarcely one Indian in five survived the first year of his labours. More than twelve thousand Indians were annually subject to the *mita* conscription of the single province of Potosi; and it is computed that upwards of eight millions of human beings perished in the mines of Peru alone.[1] The Indians were also pressed into the employment of the governors of provinces and others; a species of servitude which was perfect liberty compared with that of the mines.

The *repartimiento* was a privilege originally granted to the corregidors or governors of districts, empowering them to furnish to the Indians, at a fair price, articles of necessary consumption. In course of time this privilege degenerated into a compulsory and oppressive exaction. Not only were the most worthless commodities forced upon the Indians, who were compelled to pay for them doubly or even triply, but also articles for which they had no earthly use; for instance, razors for men who had no beards, spectacles for those who had "the eye of the hawk" even in old age, and silk stockings for Indians who go barefoot. Even luxuries, the very use of which was unknown to them, formed part of the supplies which they were compelled to purchase. The collection of the royal tribute afforded the corregidor another pretence for exactions; whilst the priests to whose spiritual guidance the Indians were assigned plundered them without mercy, of all that escaped the rapacity of the governors. "The atrocities committed by these wolves in sheep's clothing," says Miller, "would almost surpass belief, were they not given on the authority of such men as the Ulloas, and had we not before us recent facts which confirm their statement." But the bow, however elastic, may be bent until it recoils. An insurrection broke out in the year 1780, and threatened the most disastrous consequences to the Spaniards; but it ultimately proved fatal to Tapac Amaru and the other Peruvians engaged in it.

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[1] Memoirs of General Miller, vol. i. p. 5. There is probably great exaggeration in this estimate; for, besides the difficulty of accounting for such a mortality in mines which subsequently have not proved at all so mortal, we learn from Ulloa that a considerable proportion of the workmen served voluntarily. Certain it is, however, that wherever mines were wrought in a compulsory manner, an alarming decrease took place in the Indian population. In a memorial presented to Philip III. in 1609, Captain Juan Gonzales de Azevedo asserts, that in every district of Peru in which Indians were compelled to labour in the mines, their numbers had been reduced to one third, and in some places to one half, of the population in 1581. Amongst other causes of this decrease may be mentioned, the civil wars; the expeditions of the Spaniards, in which vast numbers of the Indians perished; the small-pox, peculiarly fatal to Indians; and the immoderate use of spirituous liquors.

In the celebrated war of independence, which was fomented in the year 1808, and broke out over all the Spanish possessions in South America two years afterwards, Peru was the last to join; and it was there that the royalists made their final stand in behalf of the mother country.[1] They were powerful enough to restrain the spirit of revolt until the year 1821, and probably would have done so for a much longer period, had a foreign force not come to the aid of the patriots. It soon became evident to those who had established the independence of Chili, that the conquest of Peru was necessary to its security; and the project for achieving it attracted to their cause many military adventurers from Europe, now restored to profound peace by the fall of Napoleon. Amongst others, Lord Cochrane, and several English officers who had distinguished themselves in the naval service, found employment in the fleet, which was speedily equipped, and which, in discipline, though not in force, soon attained so decided a superiority over the navy of Spain as to give it the command of the navigation of the South Sea. Being to windward of the Spanish ports, it was easy at any time to choose the point of attack. Under San Martin was formed an army of 5600, which, with the fleet, consisting of one ship of sixty-four guns, one of fifty, one of thirty-six, and one of thirty-two, besides some corvettes and transports, sailed from Valparaiso, in the latter end of 1820, and reached Lima in February the following year. The troops were landed to the northward of Callao, and continued, without making any great exertion, till May, when the garrison of Lima being much straitened, an armistice was concluded.

Pezuela, then the viceroy of Lima, was opposed by the audiencia and the municipality, who censured him for not adopting measures sufficiently energetic to repel the invaders. The same disposition prevailed amongst the officers of the army, who at length resolved to depose Pezuela. He made no resistance; but having quitted the government and country, the command was placed in the hands of Don José de la Serna on the 29th of January 1821. The troops of La Serna were not much superior in number to the invaders; but some of them having gone over to San Martin, turned the scale in favour of the latter. Lima continued to be straitened by the general, and Callao to be blockaded by Lord Cochrane, who performed one of those acts of desperate valour which struck astonishment into the Spaniards. With the boats of his little squadron he entered the port of Callao, and, under the guns of its tremendous batteries, boarded, captured, and carried off one of their largest ships of war, with more men on board than were in all the boats that attacked her.

After some months had elapsed, a convention was agreed on, when La Serna with his army marched out of Lima, and San Martin with his forces entered it several days afterwards. A garrison was, however, left by the royalists in Callao. The protracted operations had given time to remove the most valuable property, which, with the females of the best families, and the non-combatants, reached the mountainous districts. San Martin, in the possession of Lima, was in the same condition as La Serna had been for some months before, with many mouths besides those of his army to fill, and his intercourse with the country that furnished provisions intercepted; but he had the advantage of naval superiority, and could draw supplies from the coast, though, till Callao was taken, the difficulty of landing rendered the arrival of such supplies very precarious.

As a measure of the last importance, San Martin sought to implant the feeling of independence, by some act which should bind the inhabitants of the capital to that cause. On the 28th of July 1821, therefore, the ceremony of declaring and swearing to maintain the independence of Peru took place. The troops were drawn up in the great square, in the centre of which was erected a lofty stage, where the independent flag of Peru was for the first time unfurled; General San Martin, who displayed it, exclaiming, "From this moment Peru is free and independent, by the general wish of the people, and by the justice of her cause, which God defend." Oaths of fidelity to the new government were afterwards taken, and, on the 3d of August, San Martin declared himself protector of Peru, and assumed the supreme civil and military command. He at the same time stipulated, that as soon as the country should be free from a foreign enemy, he would resign the command to the individual whom the people should be pleased to place at the head of the government. The offices of government were filled up by him, and General de las Heras was appointed commander-in-chief of the army. Amongst the first legislative acts of the protectorate was a decree declaring that the children of slaves born in Peru subsequently to the 28th of July preceding should be free. This was followed by another abolishing the tribute, and forbidding the name of Indians to be applied to the aborigines, who were thenceforth to be denominated Peruvians, like the Creoles. Others of less importance were added to the list of benefits conferred by the new government; but in the mean time a disgraceful scene was exhibiting at Callao, where Lord Cochrane, having come to an open quarrel with the protector, was endeavouring to gain possession of the fortress by negotiation, intending, should he be successful, to hoist the Chileno flag, in opposition to the views and policy of San Martin. The true cause of the misunderstanding it is not very easy to ascertain, nor is it of much importance. On the 21st of September the fortress of Callao surrendered to the protector; and on the 26th of the same month, he, in the capacity of commander-in-chief of the liberating army, ordered Lord Cochrane to quit the coast of Peru. General Canterac, who had meditated an attack on the patriots, for the purpose of relieving the castle of Callao, retreated to the Cordillera; so that, with no one near to create any alarm, San Martin was at liberty to take steps for the consolidation of his government and the termination of hostilities.

Unfortunately, however, recent events would appear to have thrown the inhabitants into a fever of excitement, productive of cabals which cast fatal embarrassments in the way of any energetic measures being taken. The protector, in endeavouring, with the very best intentions, to promote those who had declared for the patriot cause, gave great umbrage to certain persons by his appointments, and they unfortunately led to a disastrous prolongation of the contest. General Tristan, who had received the command of a body of troops at Ica, allowed himself to be surprised and his retreat cut off by Canterac, who took one thousand prisoners, besides some pieces of artillery, and other spoil. This reverse threw a damp over the minds of the people, who had previously lent their cheerful aid to the cause; but any seriously bad effects were prevented by the victory which the patriots gained over the royalists at Pinchincha on the 24th of May 1822. Passing over a short visit which the protector of Peru paid to the liberator of Colombia at Guayaquil,

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[1] The events connected with the early part of the revolutionary struggle will all be found recorded under the heads of BOLIVIA, COLOMBIA, CHILI, and BOLIVAR.

Peru.

and the result of which was not so satisfactory as had been anticipated, we find the protector resuming the supreme command on the 21st of August. Secure of the support of the army, he would have experienced little opposition in quelling the spirit of insubordination manifested both by the civil authorities and the people, had he resorted to compulsory measures; but this would have been in opposition to his usual policy, and might have justified the clamours of his enemies. One alternative alone seemed left to him. Agreeably to a decree issued by the council of state, deputies had already been summoned; and on the 20th of September the congress was installed in due form. The protector repaired in state to the hall of the deputies, where, divesting himself of the insignia of supreme power, he resigned his authority into the hands of the representatives of the people. He then withdrew, and immediately set out for his country-seat near Callao, leaving behind him a proclamation as his farewell address. This document embodied his reasons for retiring, and contained some wholesome advice to the new republic. Congress lost no time in appointing a new executive, under the title of the Junta Gubernativa; and Xavier de Luna Pizarro was chosen president of the congress. One of the first acts of that assembly was to decree that San Martin should bear the title of Founder of the Liberty of Peru, and enjoy a considerable pension; whilst the thanks of the Peruvian nation were likewise awarded to Lord Cochrane for his achievements in the cause of Peruvian independence.

The proceedings of the new government were marked by feebleness and discord. An unsuccessful effort to reduce the royalists increased popular clamour against the government junta, which was at last expelled from power, and Colonel Don José de la Riva Aguero was made president of the republic. Santa Cruz, a Peruvian, who in the sequel greatly distinguished himself, assumed the chief command of the army; and it was determined in a council of war to make another effort in the Puertos Intermedios. Whilst they were employed in this enterprise, General Sucre arrived at Lima with 3000 Colombian troops; but this force, with 2000 Peruvians, partly militia and partly the wreck of a former army, was found insufficient for the protection of the capital, against which Canterac advanced at the head of 9000 well-disciplined men. Lima was accordingly abandoned by the patriots, and immediately taken possession of by the royalists, who, however, soon afterwards evacuated it, after having exacted heavy contributions from the remaining inhabitants, and destroyed the mint. Both Generals Santa Cruz and Sucre, who with a united army might have accomplished something of moment, proved unsuccessful; and the former allowed himself to be out-generalled by Canterac. The cause of independence in Peru seemed hanging by a thread, which it required little exertion to break, when the celebrated Bolivar made his appearance in Lima on the 1st of September 1823. He was received with the greatest enthusiasm, and was immediately invested with supreme authority, military and political. Great activity was now infused into the measures of government; and, acting in the capacity of dictator, Bolivar dissolved congress, and levied an army, with which he sallied from the capital on the second week of November. Riva Aguero, who refused to join him, was imprisoned by his own troops, who immediately submitted to the dictator. But a fresh misfortune awaited the patriots in the mutiny of the soldiers at Callao. The consequence was, that this town, along with the city of Lima, once more fell into the hands of the royalists. The cause of independence in Peru now seemed desperate; but the conduct of Bolivar at this critical moment is deserving of the highest praise. By his firmness, activity, and seasonable severities, he checked farther defections, and obtained the respect and entire confidence of every true patriot. Nor did he disappoint public confidence; for in less than a year from that time South American independence was finally established.

In the month of July 1824 the liberating army commenced its march towards Pasco in three divisions, two of which were Colombians, headed by Generals Lara and Cordova; and one was Peruvian, under Lamar. General Sucre was chief of the staff of the whole army. In his preparatory measures for facilitating the passage of the troops to Pasco, a distance of two hundred leagues, through the most mountainous region in the world, this officer displayed great skill; and the army, 9000 strong, reached its destination in safety, and unmolested by the royalists. Various manœuvres now took place; and in an action of cavalry the patriots inflicted a severe blow on their adversaries. A series of marches and countermarches occupied the months of August, September, October, and November; and on the 6th of December the patriots reached the village of Quinua; whilst the royalists, by entering Guamangilla, cut off their retreat, and placed them in an extremely critical situation. On the 8th the viceroy, La Serna, moved from this position, and occupied with his whole force the heights of Condorkanki, within gun-shot of the encampment of the patriots. Between the opposing armies lay the plain of Ayacucho; and as a battle on the following day had become inevitable, on this plain were to be decided the destinies of South America. It is in shape nearly square, about a league in circumference, and flanked right and left by deep and rugged ravines. The eastern boundary is formed by the abrupt and savage ridge of Condorkanki, whilst its western extremity is the Indian village Quinua, a little distance in front of which lay the patriot army, not 6000 strong, that of the royalists being fully one third more numerous. Next morning, the 9th of December 1824, the expected conflict took place, and continued for about an hour, when the royalists were defeated with great loss. Indeed their army may be said to have been almost annihilated; for 3200 rank and file, amongst whom was the viceroy, were made prisoners of war, the remainder dispersing in a state of total disorganization in all directions. The battle of Ayacucho is pronounced by Mr Miller "the most brilliant ever fought in South America;" and it may be considered as the last regular engagement, although not the last struggle, in which Spain was engaged for the recovery of her revolted colonies. Rodil still held out at Callao for the mother country, with the most desperate tenacity. It was a gallant, but at the same time an unnecessary and hopeless defence, when nearly the whole of the vast continent had declared for the cause of independence. Many families of the highest rank, who had shut themselves up with this determined individual, were exterminated by disease or famine. For thirteen months he sustained, unaided, bombardments both by sea and land, rendered still more terrible by the accumulated miseries of pestilence and nearly utter want of food. He capitulated upon honourable terms on the 19th of January 1826, and thus the last link of the chain which had bound seventeen millions of Americans to the tottering monarchy of Spain was finally broken.

But although thus happily relieved of the presence of a foreign enemy, these infant republics could not agree amongst themselves; and, from the period of their establishment down to the present time (1838), their history is disfigured by a series of altercations, intrigues, plots, and counterplots, which have materially retarded their proper consolidation, and the advancement of the arts of peace. Bolivar was exceedingly desirous that the constitution which he had framed for Upper Peru, now named after him Bolivia, should be adopted by Peru proper; but public opinion was strongly opposed to his wishes. The Peruvians, also, apparently the most fickle of the fickle, began to feel their Colombian allies a burden to them. In short, whilst the national manners and habits of the Colombian troops were the opposite of congenial to them, the dislike with which the latter were regarded, from this dissimilarity of tastes, increased the hatred of the Peruvians for the Bolivian code. This spirit soon led to the formation of a strong party, which in its turn gave birth to a conspiracy, having, it was said, for its object the assassination of Bolivar himself, and the expulsion of the Colombians. It was fortunately discovered and crushed before any evil was effected; but it served to throw the affairs of Peru into greater disorder than ever, and this was increased by the announcement of Bolivar's determination to quit the country. The public mind became fearfully excited by this intelligence, and every argument and remonstrance was employed to induce him to remain amongst them, lest his departure should reduce their government to a state of perfect anarchy. On the 17th of August the electoral college of the province, and that of the city of Lima, resolved that the Bolivian constitution should be adopted in Peru, and that Bolivar should be named Presidente Vitalicio. Their example was followed by the other provincial colleges, with the exception of that of Tarapaca. Matters of importance, however, soon peremptorily required the presence of the liberator in Colombia, and Santa Cruz was left at the head of the government.

No sooner was Bolivar gone, than the popular spirit of resistance to the Bolivian code manifested itself, and the Peruvians began to devise measures for getting rid of that system and of the Colombians together. This dissatisfaction naturally terminated in a revolt, at the head of which was Colonel Bustamente, a young Colombian. The chief officers of the Colombian army were arrested and sent home, and not long afterwards they were followed by their troops. The people now unanimously denied the right of electoral colleges to decide upon the adoption of a form of government; and when the new congress assembled at Lima on the 4th of June 1827, the Bolivian constitution was disdainfully thrown aside, the Peruvian constitution of 1823 being declared to be in force. General Lamar was chosen president of the republic, a nomination which at first gave universal satisfaction; but he soon increased the number of the troops to such an extent as to embarrass the revenues, which, it may well be believed, were sufficiently limited. The reason of this augmentation of the army soon became apparent in a furious and ill-judged proclamation of war against Colombia. The menaces of this state might furnish a plausible plea for taking a step which might be pronounced as rash, considering the wavering condition of all these infant republics; but Peru appears to have been the original aggressor. There were various motives for this declaration of war on the part of Peru, one of which was the desire of taking possession of Guayaquil, and of rendering it a Peruvian port; and on the part of Colombia the principal motive was the non-payment of the debt due by Peru, and amounting to about 3,595,000 dollars. But the foundations of the dispute were deeply laid in personal animosities and national jealousy. War being therefore determined on, Lamar entered the Colombian territory at the head of a considerable army; and at Tarqui, near Jiron, in Quito, a sanguinary conflict took place on the 27th of February 1829. The battle was obstinately contested, but terminated at last in favour of the Colombians. On the following day, preliminaries of peace were agreed to, the mild terms of which were highly creditable to the moderation and equity of the conquerors. The chief stipulations were, that neither republic should interfere in the affairs of the other, and that Peru should discharge the debt which it owed to the Colombian army. The imbecility which Lamar manifested on this occasion gave rise to a conspiracy against him, and he was formally deposed on the 29th of June by General La Fuente, who became vice-president. A plot was, however, formed against La Fuente, and he was expelled from the vice-presidency. General Gamarra was subsequently appointed president, but soon afterwards relinquished the office in favour of Orbegoso. During the early part of the year 1834 the ex-president Gamarra, along with Generals Bermudez, Frias, and Vargas, took arms against the president, and seized Junin, Cuzco, Puno, Ayacucho, and several other districts, avowing their intention of erecting the southern provinces into a separate state, of which Cuzco was to be the capital. At first the revolt was crowned with some success; but in the month of April, Bermudez's army, consisting of about 1200 men, suddenly deserted him, and went over to the president; and shortly afterwards Gamarra was totally defeated by General Miller. On the 24th of February 1835, General Salavery, who commanded the garrison at Callao, instigated the troops to declare against the government at Lima, and on the following day took possession of the city, declaring himself supreme chief of the republic. The president Orbegoso, with about 200 troops, retired to Pasco. Salavery having swelled his force by the troops which had in the previous year revolted under Gamarra, extended his authority over nearly the whole of Peru. Orbegoso, unable of himself to recover his lost power, retired within the limits of Bolivia, and applied for assistance to Santa Cruz, the president of that republic. Santa Cruz joined them at Arequipa with a Bolivian army, and the united forces entered Peru, advancing as far as Cuzco. Here the army of Salavery was stationed under the command of Gamarra, for the usurper himself found it necessary to remain at Lima, to maintain his authority against the odium excited by his arbitrary exactions. The two armies delivered battle at Yauacocha on the 13th of August, when Gamarra was totally defeated, the greater part of his troops having gone over in a body to the enemy. Salavery lost no time in making preparations to defend himself to the last extremity within the walls of the capital. He called out a levy *en masse* of the province, including all freemen of colour between the ages of fifteen and forty-five, without exception, and declared, that if his orders were not obeyed, and a stout defence cordially prepared for, he would set fire to Lima as soon as Orbegoso and Santa Cruz should appear before it. He changed his intention, however; and having collected a body of about 2500 men, took the field, and posted himself on the heights of Challapampo, to the north of Arequipa. Towards the end of January 1836, the united forces of Orbegoso and Santa Cruz, amounting to double the number of those of Salavery, advanced to attack him. But he had fortified himself in such a manner that it became necessary to construct works, which, however, were soon completed. In order to cut off his retreat, and also intercept his communication with some vessels which had been prepared to be sent against Bolivia, General Miller was despatched with a sufficient force, and on entering Isla he made prisoners a general and some other officers destined for the Bolivian expedition. In the mean time, Santa Cruz, finding it impossible to attack Salavery in his fortified position, adopted a stratagem which proved completely successful. Having ordered his army to make such a retrograde movement as made it appear that he was in full retreat, the rebel army, believing this to be the case, began to debouche from the pass of Tingo on the morning of the 7th of February. Santa Cruz, seizing the favourable moment for attacking the enemy, fell upon them with great promptitude and vigour. The combat was obstinate, but the issue was not at any period doubtful. Salavery was completely defeated; and so well concerted had been the plans of Santa Cruz, that very few escaped, excepting such as dispersed themselves singly over the country. Amongst the prisoners were 220 officers, including Salavery himself, who, along with seven other officers, two of whom were generals, were tried by a court-martial, condemned to death, and shot on the 18th of February 1836. The port of Callao, Lima, the squadron destined for

Bolivia, and all the provinces of Peru, immediately submitted to the restored government.

It now appeared doubtful, however, whether the president of Bolivia had been altogether the disinterested ally which he had at first appeared, and whether Orbegoso had not purchased his assistance by secret engagements. At all events, it was now discovered that Peru was of too great extent to be governed as one state. An assembly of deputies from the southern departments was held at Sicuani on the 17th of March, under the protection and guarantee of Bolivia, when the independence of these departments was solemnly declared, and a new state formed, called South Peru, composed of the departments of Arequipa, Ayacucho, Cuzco, and Puno. The chief power was intrusted to General Santa Cruz, as supreme protector of South Peru. In the month of July of the same year, a similar assembly of deputies from the northern departments of Junin, Lima, Libertad, and Amazonas, convoked by Orbegoso, followed the example of the southern provinces, and formed themselves into an independent state, under the name of North Peru, Orbegoso being appointed president.

During the year 1837, these republics continued in an unsettled state, and the old differences with Chili led to a declaration of war on the 17th of May, the united provinces of Rio de la Plata having joined Chili against the Peruvio-Bolivian confederation. Fortunately, however, after menacing each other for a few months, a treaty of peace was concluded between Chili and Peru, on the 17th of November 1837.

Con- tion.

The constitution established by a congress of the three confederated states of North and South Peru, and Bolivia, is modelled upon that of the United States of North America. The government consists of three powers, namely, the legislative, the executive, and the judiciary. Each of the three republics has its own distinct congress; and, collectively, they may be said to form a federal republic, united to one another for mutual support and protection. Every second year a general congress is assembled, and is composed of a senate and chamber of representatives. The members of the senate are elected for life, thirty candidates being sent from the different departments of the confederation, from which number the president chooses fifteen. To become eligible for a senator or representative, the candidate must possess landed property, or an income arising from some branch of industry, of 2000 dollars for a senator, and of 1000 dollars for a representative. The head of the confederation is chosen by the general congress, out of six candidates proposed by the three republics. This head of the government is elected for ten years. He may be accused and condemned by the general congress for the crime of high treason, or if he attempt to hold the reins of government beyond the lawful period fixed by the constitution. The ministers of state, consuls, diplomatic agents, magistrates, and so forth, are responsible to the general congress, but can only be accused by the chamber of representatives. The congress by which the form of government was agreed to, appointed General Don Andre Santa Cruz protector of the Peruvio-Bolivian confederation for the first period of ten years. Santa Cruz is thus virtually at the head of three independent states. Although, nominally, Orbegoso has been president of North Peru since the 30th of December 1833, he cannot be viewed in any other light than in that of a vice-president, who governs the internal affairs of one of the states of a federal union, the supreme head of which is the fortunate soldier above named. With regard to the constitution of the individual states, little else has yet been agreed to, excepting that the government of the countries shall be intrusted to a senate and house of representatives.

By the division of Peru which took place, the departments of Lima, Libertad or Truxillo, Junin, and the Pampas, form one republic, under the name of *North Peru;* and the departments of Arequipa, Ayacucho, Cuzco, and Puno, another republic, under the name of *South Peru.* But as the limits of each are yet imperfectly defined, and as they are still to a certain extent united, we shall now proceed to give a general description of them as forming one country.

Peru.

Territorial divisions.

The territory of Peru is separated from the republic of the Equator on the north by the river Tumbez, in latitude 3. 34. south, but for about three geographical degrees this part of Peru is a comparatively narrow peninsula, projecting from the main body of the country. In about latitude 6. 30. south, an imaginary and very irregular line separates it on the north, first from the republic already mentioned, and afterwards from Brazil. On the east and south-east it is separated from the latter country partly by the river Itenez, partly by the river Madera, the great tributary of the Amazons, and partly by a line drawn through barbarous regions, which may be said to belong to either country or to neither. Throughout its whole extent on the west and south-west it is washed by the Pacific Ocean; and on the south it is bounded by Bolivia, the limits of which are not yet settled; but the most southerly land of Peru does not extend beyond the twenty-second parallel of south latitude. From this point, as far towards the equator as fifteen degrees south nearly, the country is only a long and narrow strip of land, forming the province of Arequipa, but beyond this meridian it enlarges prodigiously. In longitude it extends from about 62. to 82. west from Greenwich.

The entire length of Peru from north to south, including the long and narrow peninsula of Arequipa, is estimated at fifteen hundred miles; but its coast-line, which is winding, and has an oblique general bearing from north-west to south-east, cannot be less than 2100 miles. The breadth of Peru is also very great towards its northern boundary, but 700 miles may be taken as its average extension from west to east. According to the careful estimate made by Humboldt, Peru comprises an area of 41,500 square leagues.

Western Peru.

The surface of this immense territory is of the boldest and most varied description. By far the most striking physical feature of all the countries of South America bordering on the Pacific is the colossal mountain-ridge of the Andes, which traverses them from south-east to north-west, in a line nearly parallel with the coast, the bendings and windings of which it follows with remarkable fidelity. Humboldt, who has carefully traced the course of these mountains, describes them as separating in the vicinity of the celebrated city of Potosi, in 19. 35. of south latitude, into two parallel chains. These, however, reunite at the northern extremity of the great basin of Lake Titicaca, between latitude 14. and 15., and so form again an undivided ridge, which runs parallel with the coast line to the northern extremity of Peru, and beyond it. There are, however, other chains, apparently branches of the grand ridge, which have a general bearing from south to north, and in some parts enclose elevated tracts of table-land. In the western or Pacific ridge, immense summits are seen from the cities on the coast, towering in lofty succession above the region of perpetual snow; but the mightiest part of the range is situated in Bolivia. Between the Andes and the Pacific Ocean extends the plain or western part of Peru, and few countries of the globe present a more singular physical character. It is a belt or zone of sand nearly two thousand miles in length, and the average breadth of which is not more than thirty miles. In some parts it is as little as seven, and in others it exceeds fifty miles in width; and in this enormous stretch of country, the general character of which is aridity, there are intervals of many leagues between the different towns and cities, in which neither inhabitants nor any traces of vegetation are visible. No rain falls throughout the whole of this desolate Sahara of the west, and thunder and lightning are unknown. In explanation of these singular circumstances, it has been conjectured, that the chain of the Andes, which runs along its eastern boundary like an immense rampart, to repel the encroachments of the deep, intercepts the clouds which come laden with moisture from the Atlantic, and that the constant winds from the south drive the vapours that collect in the antarctic circle beyond the limits of Peru before they discharge their humidity. But, as a compensation for the want of rain, there is uniformly a very heavy fall of dew during the night; and the country is also intersected by rivers, streams, and torrents, by which, at intervals, strips of the long and dreary waste are redeemed from natural sterility. The insulated valleys thus formed constitute the whole habitable parts of Western or Lower Peru, as it is sometimes called; but they are situated from twenty to ninety miles apart. The banks of the water-courses are the parts which, by being laboriously irrigated, are rendered fruitful, and peopled in proportion to the supply of water. During the season when the snows of the Andes melt, the rivers swell to a prodigious extent, and can only be crossed by means of a balsa, which is a raft or frame-work fastened upon four bulls' hides sewed up, made air-tight, and filled with wind. A few of the large rivers reach the sea, but the smaller ones are exhausted in irrigating the cultivated patches, or are absorbed by the encompassing desert. "No stranger can travel from valley to valley," says Miller, "as the inhabited strips are inappropriately called, without a guide; for the only indication that the desert has been trodden before, is an occasional cluster of bones, the remains of beasts of burden that have perished. The sand is frequently raised into immense clouds by the wind, to the great annoyance of the traveller, who generally rides with his face muffled up." The habitable parts of Western Peru, therefore, are merely a series of oases in a great desert of sand, similar to those of Africa. It presents great inequalities of surface, and some of the sand-hills attain the elevation of mountains. But size is a relative term; and in the presence of the stupendous back-ground of the Andes, which lessens all neighbouring objects, they shrink into mere hills of diminutive size. The constant evaporation which is continually going on, as is evinced by the great nocturnal fall of dew, produces a haziness in the atmosphere, and the sun seldom appears with that brilliancy which it displays in the higher levels. Indeed, for six months of the year, a fog, which is considered as very beneficial, hangs over the country; and although, at the most, it attaches itself as a fine mist to woollen clothing, the Limanese call it aquaceros, a torrent. The heat is seldom so intense as to prevent the labourers from working in the open air, and the thermometer rarely rises to above seventy-five degrees. The medium height throughout the year, in which there is little variation, is about sixty-four degrees. In this district are produced most of the tropical plants. The plantain, banana, pine-apple, sugar-cane, vine, cocoa, olive, coffee, and cotton, as well as the most delicious fruits, some peculiar to the country, arrive at great perfection.

Peru of the Andes.

As we advance from the coast towards the Andes, vegetation becomes more luxuriant, for as the growth of plants depends upon the supply of water, that supply is greatest the nearer we approach to the sources of the streams. The range of the Andes nearest to the Pacific Ocean commences generally with hills of moderate elevation, but in some parts with bold, projecting, and abrupt precipices. The sides of these hills are covered with forests, rendered almost impenetrable by the numerous parasitical plants which twine around the lofty trees, and, whilst by their verdure they give beauty to the scenery, prevent the access of visitants until a path be cut out by severe labour. These forests, hundreds of leagues in extent, afford acacias, mangle trees, arborescent brooms, and ferns; aloes and other succulent plants; cedars, cotton or Cuba trees of gigantic magnitude, many kinds of ebony, and other useful woods, many species of palms, and the maria, a tree of enormous size, used in ship-building. The valleys between the hills afford most of the trees which are natives of the tropics; but few of them are well fitted for the purposes of building.

The district called Higher Peru, commencing at the termination of the sands on the shore, continues increasing gradually in height towards the east, until the ridge of the Andes or the Cordilleras is attained. The line of perpetual snow is about 14,000 feet above the level of the sea, and from that line upwards vegetation necessarily ceases; below it, the plants, by regular gradations, display the nature of the climate, and its adaptation to the various families of vegetables; and, in different parts, exhibit every species of production which can be found, from the dwarf plants of Lapland, to the odoriferous spices of Sumatra.

This portion of Peru contains the sources of those vast rivers which traverse the whole continent of South America, and are the greatest on the face of the earth. Here the Maranon commences its unrivalled course; and here rise its magnificent tributaries, the Ucayale, Huallaga, and others, which themselves are swelled by an innumerable multitude of streams, descending from the eastern ridges of the Andes, all being finally absorbed by the monarch of the waters. This mountainous region of Peru possesses large tracts of soil of great fertility, and a climate admirably adapted for raising food for man. The air is much purer and more salubrious here than on the coast, where its heat and humidity generate fevers. There is a great variety of climate in the Andes, as may easily be inferred from the character of the country, rising as it does from nearly the level of the sea to a height far above the line of perpetual refrigeration, and thus presenting on one and the same parallel of latitude the different climates of all the regions of the globe. The valleys and plateaus embosomed in these mountains, in spite of their vicinity to the region of eternal snow, enjoy a moderate climate, and are very fertile. These are eagerly sought as an abode, especially by the Indians; and by the productions here cultivated the inhabitants of the coast are almost entirely supported. The number of articles of culture might be still further increased, for many useful plants hitherto unknown might be naturalized, if care were taken to ascertain the locality, and the relative proportions of atmospheric heat which they require, previously to their being transplanted. In this mountainous district are situated the famous gold and silver mines of Peru, the source of its unrivalled wealth, and the cause of all the misery which it endured for three centuries of slavery and degradation. They are seated deep in the recesses of the Andes, and at great elevations, so that the climate is very cold, and alike unfavourable to vegetation and to the health of man. The celebrated mines of Pasco and Huancavelica are between 13,000 and 14,000 feet above the level of the sea.

Eastern Peru.

But by far the largest, most beautiful, and most valuable part of the Peruvian territory lies to the east of the Andes, commencing on the eastern declivity of the second chain, and stretching to the confines of Brazil. In this vast region a thousand sources of wealth still lie buried, for the greater part of it may be said to be yet unknown, and the riches which it contains are immense. "Here are plains traversed by lower hills," says Dr Poeppig, "covered with an ocean of foliage, vying in beauty with the climate of Chili, and far surpassing it in the abundance and luxuriance of its productions. To these join, within the extensive frontiers, those boundless plains, where gigantic rivers, which roll their broad waves through solitary forests, are the only means of communication between the widely-scattered dwellings of a very scanty population."[1] In a word, as far as we are acquainted with this region, it appears to rival the finest parts of Brazil in fertility, luxuriance, and variety of vegetation; and the world does not present us with any higher standard of comparison. The vast plains in which the declivities of the Andes terminate are called sometimes Pampas del Sacramento, or more usually Collona, or the Land of the Missions. This name they owe to the Jesuits, whose zeal for the conversion of the natives induced them to penetrate these trackless solitudes, and to gladden them with the tidings of great joy. They planted a number of settlements throughout this vast unviolated wilderness, and, by collecting in villages the rude inhabitants, attempted to civilize them, not only by instilling into their minds the doctrines of religion, but by teaching them such arts as their limited natural talents enabled them to acquire. Many of these missions still exist, and, by the good which they have done and are still doing, they in some degree atone for the injuries inflicted on Peru by its subjugators. The Indian tribes who inhabit the Pampas are too numerous to be specified individually. They are small and scattered, with as many various languages as there are tribes or divisions, and differing much from each other in the degree of civilization to which they have attained. Some of them are docile and cheerful; others are savage and warlike, and continually in a state of hostility with one another. The banks of the Huallaga, the Ucayale, and other great rivers, are the parts most thickly peopled by the Indian tribes. The Pampas are represented as being covered with trees and verdure, and yielding balsams, oils, gums, resins, and many valuable drugs, spices, and other rare productions. The trees are lofty, and form impenetrable forests, in which wander all the animals peculiar to the torrid climate of America.

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[1] Poeppig's Travels in Chili, Peru, and on the river Amazons, in the years 1827–32; a valuable German work on South America.

Pan del Sacr en-to.

The following excellent account of a very interesting portion of this vast territory is by a recent explorer of these regions. "The Pampa del Sacramento was so called from its having been discovered by some of the newly converted Indians in 1726, on the day of the festival of Corpo de Dios. It comprises the greatest part of the land lying between the Huallaga, the Ucayale, the Maranon, and the Pachitea (an upper tributary of the Ucayale, which rises near Pasco); and it is remarked with apparent justice in the Viagero Universal, that the two continents of America do not contain another country so favourably situated or so fertile. It is about three hundred miles long from north to south, and from forty to about a hundred in breadth. Two of its boundary rivers, the Maranon and Ucayale, are at all times navigable for vessels of large burden, and the other two for boats and small craft. There are a great many streams which rise in the centre of the district, some of which fall into the Ucayale, and others into the Huallaga, most of which are navigable for canoes and flat-bottomed boats at all seasons; those which fall into the former of these rivers are the most considerable, viz. the Pachitea, the Aguaytia, the Cuxhiabatay, and the Santa Catalina. The northern part is much intersected by channels from the Huallaga to the Maranon, which afford great facilities for communication. This part of the Pampa appeared to be quite flat and thickly covered with trees, some of which were large, and the soil a red clay. The level extends as far south as Sarayacu, in the neighbourhood of which, and across the Huallaga, it rises into gentle hills. Farther southward we had no opportunity of seeing the country, except upon the banks of the Huallaga, which were generally level, but occasionally intersected by hills, which, indeed, near the Pongo, and from the Caracol, where we embarked on the river, to Juana del Rio, are entitled to the designation of mountains. The hills which are marked in Mr Arrowsmith's map of Peru and Bolivia, published in 1834, as the east branch of the Andes, are not deserving of the name of mountains. The productions of the Pampa, as we learned from Padre Plaza (the present missionary priest) are all indigenous, and in general spontaneously produced. The earth supplies vegetables sufficient for the consumption of the inhabitants; and the rivers furnish an inexhaustible store of delicious fish of various kinds. The beasts in the forest are the same as are to be found in all parts from the Huallaga to Para. By the Padre's account, however, they are not numerous, from the great destruction of them by the Indians, which is sometimes wanton. There is an almost endless variety of beautiful birds, many of which are excellent food. The vegetable kingdom, which has hitherto been unexplored by botanists, rivals in beauty and fragrance that of any other part of the world. The climate seems very much like that of the island of Madeira. During our stay at Sarayacu, we registered the thermometer three times a day, and its minimum and maximum were 75° and 85° of Fahrenheit, and the sun at this time passed over our zenith. Padre Plaza told us, that in the dry season, that is, in June, July, and August, the temperature is extremely even, and the heat by no means oppressive, as it is allayed by refreshing breezes, which generally blow in the contrary direction to the current of the river. In December, January, and February, fevers and agues sometimes make their appearance, but are rarely attended with fatal consequences, when the parties affected take proper care, which these people, however, are not apt to do."[1] This fine and fertile garden of nature is inhabited by ten distinct tribes of Indians, differing considerably from one another in their manners and habits.

The Spaniards, and even the Peruvians before them, made little progress to the east of the stupendous barrier of the Andes, which indeed must for ever prove a great natural disadvantage to the eastern provinces, in shutting them out, as it were, from communication with the western portion of Peru. And when to these obstacles we add the precipitous height of the eastern declivity of the mountain chain, the impracticable forests, the dangers to be apprehended from the barbarians which people them, the almost insufferable heats, the annoyance of the innumerable venomous insects and reptiles, and the many deep and impassable rivers; when these circumstances are considered, we may cease to wonder that the conquerors of Peru should have made small advances beyond the range of the Cordillera. The Gran-Chaco, or Great Desert; the countries between Paraguay and Chiquitos; those reaching from Moxos and Apolobamba to the rivers Amazons and Huallaga, and from the Apurus to the Ucayale, are regions almost wholly unknown to us. Wherever the interior has been penetrated, it has been by means of some of those mighty rivers which, descending from the Cordilleras, have forced, as it were, a natural outlet through the otherwise impassable and almost boundless forests below. It was not, however, from the coasts of Peru, and by proceeding in an easterly direction, that the Spaniards reached them. They were originally made known by adventurers from the south, who discovered them, after toiling up the long and arduous passage of the river Paraguay. The difficulties with which the nations to the eastward of the Andes have to contend in the transport of their productions across the Cordillera, of course add very greatly to the expense of these articles. Those of Chiquitos and Moxos are transported more than two hundred leagues to Lima, over a double range of the Andes; and if they are taken to Buenos Ayres the distance is tripled. Nothing but gold, silver, and precious stones can repay the enormous expense of transport on beasts of burden over such extensive tracts of country, beset with all but insurmountable natural obstacles. It is not surprising, therefore, that with such impediments before them, the natives should relinquish the idea of cultivating the soil for the purpose of exportation, and remain content with raising what is barely sufficient for the supply of their own daily wants. But an entirely new road to Peruvian commerce might be opened by means of the vast rivers which traverse the country.

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[1] Journey from Lima to Para across the Andes, by Lieutenant Smyth and Mr F. Lowe, p. 200 et seq. 1836.

Amidst the various circumstances which distinguish Peru, there are some of the most calamitous and terrific description. The whole country is subject to the most violent convulsions of nature. Earthquakes are frequently felt in almost every part, and are sometimes accompanied with most extensive and fatal effects. The lofty chain of the Andes is a collection of volcanoes, some in constant activity, others occasionally ejecting inflammable substances; whilst there are many whose fires in the lapse of ages seem to have burned out. Electrical phenomena are frequent in the Andes of Peru, some of which are regarded with superstitious veneration by the Peruvian of the lower class. When he sees a silvery lustre glistening through the clouds at midnight from the summit of a lofty mountain, or a phosphorescent light shining in the wooded clefts of the lower Andes, he is immediately persuaded that there are either rich veins of gold or silver running along the surface, or that the buried treasures of the incas invite the bold adventurer to search for them, which he frequently does. Appalling visitations of thunder and lightning are not uncommon in all parts of Peru excepting the western coast.

Productions.

In enumerating the productions of this country, we shall commence with those of the Pampas, where by far the most valuable of them are to be found. We pass over the flora, which is unusually rich and extensive, and also plants of a humbler character; for, although interesting to the man of science, they would form but a dry catalogue of botanical names to the general reader. The vegetables which at present form articles of use or commerce are, coffee, sugar, rice, maize, capaiva, sarsaparilla, Peruvian bark, cotton, resin, cocoa, and gums, including copal and laurel wax, bees' wax, and a variety of oils. Of dye-stuffs there are, anatto, amarillo, cani, mahogany-bark, indigo, shambo, morado, ensena which resembles logwood, and others. In describing the qualities of some of these, and the quantities in which they are produced, Thadeus Häenke observes, "The cocoa of Apolobamba, of Moxos, of Yuracarees, and of all the woods which extend from thence to the shores of the Maranon, is infinitely superior to that of Guayaquil. The finest quality of carscarilla is only found on the eastern side of the Andes. Of the indigo there is no end; I can say the same of the cotton and the rice. The precious balsam of capaiva, the sarsaparilla, the gum-elastic, and the most fragrant species of vanilla, are all produced in extraordinary abundance in these regions. The mighty forests which line the shores of the rivers abound in the finest timber for all uses, especially for ship-building, and in trees distilling the most aromatic and medicinal gums. Amongst others there is a species of cinnamon, called by the natives the *canela de clova*, which only differs in the greater thickness of the bark and its darker colour, according to its age, from that found in the East Indies, and which is as fragrant as the spice from which it takes its name."[1] Lieutenant Smyth describes the woods as consisting of mahogany, cedar, asarquiro, nogal, almendra, huito, arabisa, chonta, spindo, and others. The fruits are the pine-apple, which attains an incredible size, the orange, chirimolla, lucuman, ciruellas, patillos, guayabas, figs, limes, citrons, papayas, melons, water-melons, lemons, granadas, granadillas, apples, avocater pears, olives, pomegranates, cherries, peaches, quinces, grapes in abundance, bananas, pepinos, plantains, guavas, peras, duraznos, strawberries, mulberries, and a number of others. There are a great variety of vegetables, including yucas, potatoes, sweet potatoes, onions, mountain-cabbage, beans, and so forth. The grains usually cultivated are wheat, barley, and maize. In some parts excellent tobacco is raised; and in others large quantities of sweetmeats, both dry and in syrup, are made from peaches, quinces, and grapes, the latter being much esteemed. Gourds attain an enormous size in some districts, and are converted into all kinds of household utensils required by the Indians, even into wash-tubs, from which circumstance some idea of the magnitude of the vegetable may be formed. Huanuco, a place situated at 6300 feet above the level of the sea, in a beautiful valley upon the eastern side of the Andes, and seventy-four miles from Lima, is celebrated for the productiveness of its soil. Here grow all sorts of vegetables, and grains and fruits, the latter being produced in greater perfection than in any other part of Peru. There is a fruit called chonta, from which the Indians prepare an intoxicating liquor; but the staple article made use of for producing the effects of wine, spirits, or opium, is coca; and as this remarkable plant is very extensively cultivated, and has now become an indispensable necessary of life amongst the Indians of the Andes, it merits some attention.

Coca

The coca (*Erythroxylon coca*, Lam.) is a bush from six to eight feet in height, somewhat resembling a black thorn in its numerous small white blossoms and the lively bright green of its leaves. The latter, which are gathered and carefully dried, form an article of brisk trade, and the use of them seems as old as the first knowledge of the history of Peru. It is a stimulant, which acts upon the nervous system in the same manner as opium, and unhappily the use or abuse of it has degenerated into a vice, or rather a disease, which appears to be incurable. "The Indians of America," says an able writer on this subject,[2] "especially those of the Peruvian Andes, notwithstanding the civilization which surrounds them, have a vague sense of their own incurable deficiency, and hence they are eager to relieve themselves, by violent excitements, from such melancholy feelings. This accounts not only for the use of coca, but also for the boundless love of spirituous liquors, which possesses scarcely any other people in the world in an equal degree. To the Peruvian the coca is the source of the highest gratification; for under its influence his usual melancholy leaves him, and his dull imagination presents him with images which he never enjoys in his usual state." Dr Poeppig draws a melancholy picture of the dreadful effects of this insinuating drug, which gives rise to many diseases apparently in some degree peculiar to those who use it. A person abandoned to the use of coca is under the dominion of a spell so malignant that no earthly power can dissolve it, and so fascinating that no prospect of danger will deter him from gratifying his propensity. As soon as the longing for this intoxication becomes irresistible, the coquero sculks for concealment into solitary darkness, or flies from the face of man into the depths of the wilderness, where he makes choice of a tree, beneath the shade of which he flings himself down to enjoy his coca. Unheeded he observes night closing upon him, doubly awful in the gloomy forest; and tempests of wind and rain, the fury of the hurricane which uproots the oldest trees, the terrible roll of the thunder, augmented a thousandfold by the multiplied reverberations of the Andes, or the presence of the ounce, abroad for his nightly prey, and growling at his feet, all are insufficient to appal the debauchee, or rouse him from his lethargy. In two days he generally returns, pale, trembling, his eyes sunk, the most fearful picture of unnatural indulgence which humanity ever presented. He who has once been seized with this passion, and is placed in a situation that favours its development, is considered as a lost man. Dr Poeppig informs us that there are many instances of young men of good families amongst the whites and Creoles, who, having obtained a relish for coca, were from that moment lost to the civilized world. Shunning society, they retreated into the most unfrequented parts of the wilderness, and there, degraded, and sunk into half savages, they fell victims to premature death, through the immoderate use of this intoxicating herb.

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[1] Journal of the Royal Geographical Society, vol. v. p. 97–8, 1835.

[2] Foreign Quarterly Review for April 1836.

The grapes are so abundant in some parts that large quantities of wine might be made for exportation; but no more is produced than is needed, and a little is even imported. Strong liquors, such as brandy and rum, are distilled; and oil is made from the olive. The various kinds of capsicums are cultivated with more attention and skill than almost any other plants, and, when dressed in various ways with garlic, form a most important article of food to the greater portion of the inhabitants. The celebrated Paraguay tea is likewise a very common beverage. Another liquor in universal use is chica, which, from having been found in the tombs of the aborigines, is proved to have been used by them prior to the conquest. The chica of the present day is of the consistence of milk, of a yellowish colour, and, when poured from one vessel into another, froths like beer. Its taste is generally acid, but when very good the acidity is scarcely perceptible. It is made by steeping Indian corn in water till it swells, after which it is dried and ground. The flour and bran are boiled in water, strained, and left to ferment four and twenty hours, when it is fit for use. Sugar is occasionally added; and with eggs it is sometimes made into flip.

The zoology of Peru has not received that attention which has been bestowed upon the vegetable kingdom by the distinguished travellers Humboldt and Bonpland. The three most celebrated animals of the Peruvian Andes are the lama, the vicugna, and the condor, an account of which is given in the article Bolivia. The demand for animal food is but small, and hence little attention has been paid to the breeding, and none to the fattening, of cattle. Neither cows nor sheep are numerous; those found in the country are the progeny of the breed brought originally from Europe. In the mountainous districts, between Huamanga and Cuzco, both butter and cheese are made; but in the lower country, oil is the universal substitute for the former. Pigs are bred in great numbers in the more elevated districts. The whole coast is well stored with fish of every kind. The natives of the Indian villages on the shore are very dexterous in catching them; and, with the addition of capsicum and garlic, they form the chief part of their subsistence.

Peru is proverbial for its richness in mines of gold and silver, especially the latter, although the former is proportionally plentiful. "Gold," says Thadeus Häenke, "and it is the finest in the world, is found there in such abundance, that I have no hesitation in saying there is scarcely a pass in the mountains where it is not to be discovered, although in some parts it may be of easier access than in others, and better known." The quantity of gold produced in Peru arises partly from some mines in the province of Tarma, and partly from washings established on the rapid mountain torrents. The latter, however, have in many instances been abandoned. The principal silver mines are situated in the Cerro de Pasco (see the article Pasco). There are also mines of quicksilver, which, however, are now exhausted, or nearly so.[1] Cobalt, antimony, and especially rock-salt, abound in Peru; but as these are, excepting the latter, found chiefly in the mountainous districts, the distance, and the want of roads, render their conveyance too expensive to enable them to be advantageously carried to any market of consumption. There are a few mines of copper and of lead, which, from the same causes, are worked on a very contracted scale. In the northern territory there are said to be mines of sulphur which remain unworked, and bituminous pitch is found in the same quarter. Dr Meyen[2] mentions that Tarapaca, in the department of Arequipa, has received from nature a peculiar present in its woodmines, which the inhabitants use as fuel in their saltpetre works, although probably there is not a single tree in all the surrounding country. This substance is not coal, but is stated to be dry timber, easily cleft, immense forests of which are buried under the sand of that plain. The trees all lie prostrate, with their tops towards the coast, and the timber is found exceedingly useful, burning with a flame as bright as that of common wood.

Antiquities.

Amongst the antiquities of Peru may be numbered Cuzco itself, and the ruins of other cities or towns, which have been much more recently discovered, and to which we have already alluded. There are also extensive remains of fortifications; and a great number of tumuli or sepulchral mounds are found widely scattered over the country. In these, relics of various kinds have been discovered, such as gold and silver ornaments, warlike weapons, and household utensils, comprising jars of earthenware, with figures upon them, which proves that the Indians were acquainted with pottery. Dr Poeppig informs us, that the mania of digging for treasures annually destroys in Peru many ancient and remarkable remains. Wherever the Peruvian beholds tumuli evidently raised by the hand of man, or an ancient building indicates the former abode of an exterminated people, he immediately suspects the existence of the guacas or caverns, which were filled by the incas at the time of the conquest with gold and precious stones, and forgotten at the premature death of these chieftains, who had buried their treasures from a sense of duty, and not chosen any persons as the depositaries of their secret. The work of demolition immediately commences; the abodes of the dead are rudely violated, and in their eagerness to find what alone to them is valuable, the Peruvians, and the Spaniards likewise, pay little attention to the preservation of the other interesting relics, but carelessly break them to pieces, and scatter them about. There will soon not be a tumulus left in the country. The most absurd fables have been invented and set afloat in connection with the favourite hypothesis of vast treasures remaining yet undiscovered. According to a tradition coeval with the conquest of the city of Cuzco, there is in a mountain lake in its vicinity a gold chain which went twice round the market-place, and of such large proportions that an Indian could with difficulty carry a single link of it.

Manufactures.

The manufactures of Peru are inconsiderable, and consist chiefly of those homely articles which are required by the poorer classes of the community. On the high land, where warm clothing is necessary, the want is chiefly supplied by a species of long-woolled baize, made from the fleeces of the aboriginal sheep, and in some instances from the wool of sheep of the European breed. In the valleys, and on the coast, where the heat forbids the use of woollens, cotton cloths are made, but of a very inferior texture. The Indians manufacture a variety of cotton fabrics, which are consumed in the country, such as counterpanes with raised figures. Straw-hats of a variety of colours, petates or mats, and segarreros, also form part of their manufactures; and they likewise execute a very fine filligree work of gold and silver. Goat-skins are made into good cordovan. Tanning, soap-making, distilling, saltpetre, and other manufactures, are also amongst the items of productive industry; but Peru looks to Europe for a great part of the necessaries as well as the luxuries of life. In dyeing the cloths, whether of woollen or cotton, the natives make use of plants which are scarcely known in Europe, or at least have not been applied to the same purpose. The dress of the Peruvians is very simple, consisting of a square cloth, with a hole in the centre, through which the head is thrust, and which falls before and behind so as to defend the whole body. The head is generally covered with a hat made of the straw of the maize, which is as large as, and serves the purpose of, an umbrella.

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[1] For a particular account of the mines of Peru, the quantities which they have produced, and their actual condition, see the article Mines.

[2] Meyen, Voyage round the World, Berlin, 1835.

Commerce. The foreign trade of Peru is principally carried on with the united kingdom of Great Britain and Ireland, into which the following articles were imported during the year ending January 1836.[1]

Goods exported from Peru to Great Britain.—Pot and pearl ashes, 9 cwts.; Peruvian bark, 160,152 lbs.; untanned hides, 3526 cwts.; saltpetre and cubic nitre, 41,354 cwts.; undressed seal-skins, 2222; unrefined sugar, 5782 cwts.; cotton-wool, 105,661 lbs.; sheeps' wool, 908,626 lbs.; about four cwts. of molasses; and some other articles, including a considerable quantity of gold and silver specie.

Goods imported into Peru from Great Britain.—Cotton manufactures entered at value, L.403; wheat, meal, and flour, 833 cwts.; plain linens and diaper, 1282 pieces; quicksilver, 12,025 lbs.; foreign thrown silk, 1370 lbs.; silk manufactures of Europe, 4098 lbs., and of India, 415 pieces; spirits, viz. rum, gin, and brandy, in nearly equal quantities, 11,794 proof gallons; wines of all sorts, 16,529 gallons; ale and beer, nine tuns; tea, 134 lbs.; apparel, slops, and haberdashery, L.3312 of declared value; arms and ammunition, L.332 do.; brass and copper manufactures, L.806 do.; cotton manufactures, 9,886,075 yards, the declared value of which was L.283,007; hosiery, lace, and small wares, L.9873; cotton twist and yarn, L.380; earthenware of all sorts, L.4193; glass, L.5317; hardwares and cutlery, L.15,039; beaver and felt hats, L.475; iron and steel, wrought and unwrought, L.4174; leather, wrought and unwrought, 2481; saddlery and harness, L.145; linen manufactures, 685,250 yards, declared value, L.29,736; machinery and mill-work, L.808; painters' colours, L.569; plate, jewellery, &c. L.215; salt, 2000 bushels; silk manufactures, L.8758; soap and candles, 40,224 lbs.; stationery of all sorts, L.755; tin and pewter wares and tin plate, L.1946; woollen manufactures, L.63,559; woollen hosiery and small wares, L.1117; cinnamon, 918 lbs.; gum-arabic, 13 cwts.; and there were, besides, small quantities of cocoa-nuts, nutmegs, pepper, refined sugar, rhubarb, coffee, tin, butter and cheese, coals, culm and cinders, cordage, and so on. The total declared value of British and Irish produce and manufactures imported into Peru during the year 1835 was L.441,324. By comparison with former years this shows a decided increase of our trade with Peru. In 1827 it was L.228,466; in 1830, L.368,469; in 1832, L.275,610; in 1833, L.387,524; and in 1834, L.299,235. This shows remarkable fluctuations; but these must for the most part be attributed to the political agitations of the country.

The trade of the United States with Peru is next in importance to that of Great Britain, and it displays the same fluctuations, and likewise the same increase on a number of years. The exports from Peru into the United States during the year 1835 amounted to 1,118,278 dollars. During the previous year the amount was only 618,412 dollars. A considerable quantity of gold and silver specie is imported into the United States from Peru. The imports into Peru from the United States consist of flour in very considerable quantities, raw cotton, beef and pork, butter and lard, candles, soap, chairs, cider, gunpowder, turpentine, linseed oil, tobacco, wax, quicksilver, German linen, Russian sheetings, and steel. It will be seen that these articles are for the most part different from those imported into the country by Great Britain.

The trade of Peru with France is likewise considerable. The gold and silver specie, the bark, tin, skins, hides, and other productions of the former, being exchanged for the silks, brandy, wine, and other commodities of the former. With Spain likewise a trade of much the same nature is carried on. Quantities of specie and a few other articles are sent to Genoa, Canton, and other ports. From Paraguay large quantities of the Paraguay tea are introduced. It must be observed with regard to the trade of Peru, that a considerable quantity of the produce of the country is imported into Great Britain and other places at second-hand from Buenos Ayres and Valparaiso. Indeed, much of the foreign trade of Peru is carried on through the medium of Buenos Ayres.

Peru carries on some trade with Chili, and also with the states to the north of its own territory. Timber for the construction of ships and houses is brought from Guayaquil, and indigo from Mexico. Large quantities of wheat are imported from Chili; for although Peru might easily raise a sufficiency of all kinds of cerealia to supply its own consumption, it has never been able to do so. A few years ago a heavy duty was imposed on the wheat imported from Chili, with the view of encouraging its cultivation at home. But the Chilians became indignant, and reciprocated by imposing a duty of twelve dollars per quintal on the importation of Peruvian sugars. The Peruvian congress then proposed to admit into their ports all foreign vessels at reduced duties, on condition of not touching previously at any Chilian port. The two states thus view each other with a jealous eye in their commercial affairs, and also in other respects. The moneys, weights, and measures are the same as those of Spain.

The following is an abstract of the commercial treaty lately concluded between Great Britain and the Peruvio-Bolivian Confederation.[2] It is agreed that there shall be perpetual amity and freedom of commerce between Great Britain and these countries, complete protection and security to person and property being afforded; but that the coasting trade shall be confined to national vessels. That Peruvio-Bolivian vessels, in trading with Great Britain, shall enjoy the same privileges as the traders of the most favoured nation, duties and other charges being the same; and this stipulation is reciprocal. After the expiration of fifteen years, it is agreed that there shall be no distinction between Peruvio-Bolivian and British vessels in entering each other's ports. To avoid future misunderstanding, it is also agreed that, for fifteen years, any ship, the property of a citizen of the Peruvio-Bolivian Confederation, and of which the master and three fourths of the crew are such, shall be placed on the same footing as a national vessel, that is, a vessel built in the country; but after the period specified expires, the sovereign of Great Britain is to possess the right of restricting the privileges enjoyed by a ship of either country to such as are actually *built* in that country, taken in war, or condemned for trading in slaves. That the citizens and subjects of the contracting parties, in the territories of each other, shall be placed upon the same footing as the natives, with the privilege of exemption from all compulsory military services, exactions, or requisitions, and from forced loans. That liberty of conscience and freedom of religious exercises be enjoyed; and that the Peruvio-Bolivian Confederation shall co-operate with Great Britain for the total extinction of the slave-trade. There are some other stipulations in the treaty, but these, being of minor importance, do not require particular mention.

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[1] Extracted from the parliamentary papers for the year 1836. The quantities are given in round numbers.

[2] Treaty of amity, commerce, and navigation between his Majesty William IV. and the Peruvio-Bolivian Confederation, signed at Lima, 5th June 1837. Parliamentary Papers for 1838.

Peru labours under disadvantages exceedingly unfavourable to its commerce. On the whole Pacific coast, for about two thousand miles, there are only three or four ports capable of admitting vessels of any size, viz. Callao, the port of Lima; Arica, a port of Arequipa, and a miserable place, although resorted to by trading vessels, for want of a better, it is presumed; and Islay, the new port or harbour of the city of Arequipa. It is supposed that the commerce will increase when the port of Arica is closed, which has been contemplated by government. Farther north is the port of Pisco, a small place, but enjoying some share of maritime commerce, although not a port of entry. From Callao to the confines of Colombia there does not appear to be one port worthy of the name, if we except Pacasmayo, the port of Truxillo, which is a wretched place, and Paita, the port of Piura. Add to this disadvantage that of the barrier of the Andes, which cuts off all communication, except at a great expense, between the richest part of the country and the coast where its native wealth might be readily exported. These are heavy drawbacks on all commercial industry; and, as the latter is an insurmountable difficulty, the Peruvian government must look to another quarter for an outlet for the produce of the country. This is to be found in the numerous large and navigable rivers which traverse the regions situated between the Andes and the Amazons, the great natural drain of all these territories. The advantages which Peru would derive from commercial intercourse with civilized nations are too great and too obvious to be overlooked by the government, if tranquillity were only permanently restored. But as long as these republics continue to tear each other to pieces, and exhaust their resources in fruitless warfare, little improvement in commerce or amelioration of their social condition is to be anticipated. In reference to the navigation of the Amazons and its affluents, it has been well observed by an able writer—"The time appears to be now arrived, when the solution of the question touching the course of the great rivers that empty themselves into the Amazons between the Huallaga and the Madeira may be expected. And we anticipate with confidence, that a question of so great importance in a commercial point of view, will not escape the notice of the patriotic government of Bolivia, and of its highly gifted president Santa Cruz; and that, ere long, the productions of the rich provinces of Apolobamba, Moxos, and of the other countries situated on the eastern declivity of the Andes, will find their way to European markets by the less circuitous route of the Amazon and its confluents."[1]

Revenue, finances, and war-like force.

It is nearly impossible to obtain precise information as to the amount of the present revenues of Peru. Under the colonial government of Spain, the revenues of the crown amounted, *communibus annis*, to about 6,000,000 of dollars, and the expenditure to about 3,200,000; the balance being annually remitted to the parent state. The present revenue has been estimated at L.1,250,000, the expenditure at a little less than that sum, and the national debt at about L.6,000,000. In the year 1832, it was agreed to between the states of Peru and Bolivia, that for the future the former should be obliged to maintain a military force of 3000, and the latter of 2000 men, and that neither power should be at liberty to augment its army without the consent of the other. The naval force is very small, consisting of one frigate, two corvettes, and two galliots; but this must be considered as the peace establishment. When the country is at war, it will be necessary to increase the military force considerably.

Religion, education, and morals.

According to the constitution of 1828, the religion of the republic is the Roman Catholic and apostolic. "The nation permits it by all the means that conform to the spirit of the evangelist, and will not permit the exercise of any other." It may be mentioned, that a similar article is found in the Chilian constitution of May 1833. The question of religious toleration gave rise to very animated discussions in both countries, and called forth all the powers of the author of Cartas Peruanas, in support of the exclusive exercise of the Catholic religion, and the supremacy of the pope. The work here mentioned was an examination of the evidences of Christianity, and was published to neutralize the bad effects of the infidel and irreligious books which some interested persons had disseminated throughout the country during the revolutionary agitations. Education is said to be at a low ebb. There is a university at Lima, which in 1831 had fifty-five students. This institution is the most ancient and the most celebrated in all South America. There are a number of colleges, and a national library, which is one of the richest in the New World. Ten or twelve journals are published in Lima; indeed, if this city were to be taken as a fair criterion by which to judge of the state of literature and learning in Peru, we might be led to form a very high estimate of it, for it concentrates nearly the whole in itself. But, since the revolution, extensive arrangements have been made for the general diffusion of knowledge amongst the people.

South Peru is divided into the departments and provinces specified in the following table.

Departments, with their Population in 1795.	Provinces.	Chief Towns.
Arequipa, 136,812.	Arica, Callyoma, Camana, Cercado, Condesuyos, Moquegua, and Tarapaca.	Arequipa, Arica, Camana, Huantagaya, Moquegua, and Tackna.
Ayacucho, 159,608.	Andahuaylas, Cangallo, Castrovireyna, Huamanga, Huancavelica, Huanta, Lucanas, Parinacochas, and Tayacaja.	Huamanga, Ayacucho, Jauja, Huancavelica, Lucanas, and Ocopa.
Cuzco, 216,382.	Abancay, Ayamaraes, Calca, Cercado, Cotabambas, Chumbivilcas, Paruro, Paucartambo, Quispicanchi, Tinta, and Urubamba.	Cuzco, Albancay, Tinta, and Urubamba.
Puno, 156,000.	Azangaro, Carabaya, Chucuito, Huancane, and Lampa.	Puno, Chiquito, Caillomas, and Lampa.

North Peru is divided in the same manner. The new department called the Pampas has been formed out of the territories of Junin and Truxillo; but as its extent and divisions have not yet been described in any work on Peru, we are under the necessity of giving the local geography of this republic as it stood in 1835–1836.

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[1] Journal of the Geographical Society, vol. vi. p. 186, 1836.

Departments, with their Population in 1795.	Provinces.	Chief Towns.
Lima, 149,112.	Canta, Cañete, Chancay, Huarochiri, Ica, Santa, and Yauyos.	Lima, Callao, Cañete, Chancay, Huaco, Huauro, Ica, Pisco, and Patibilca.
Libertad or Truxillo, 230,970.	Cajamarca, Chachapoyas, Chota, Huamachuco, Jaen, Lambayeque, Maynas, Patas, Piura, and Truxillo.	Truxillo, Caxamarca, Casabamba, San Juan de la Frontera, Eten, Lambayeque, Moyobamba, Micuipampa, Payta, Piura, and Sechura.
Junin, 200,839.	Cajatambo, Conchucos, Huaylas, Huamalies, Huanuco, Hauri, Jauja, and Pasco.	Huanuco, Banos, Huaras, Junin, and Pasco.

The total population, as stated above, is 1,249,723; but it is now (1838) estimated at 1,700,000. The inhabitants of Peru consist of three original castes; Spaniards, Indians, and negroes. The secondary species arising from these three are, the mulatto, from the Spaniard and negro; the quarteroon, from the mulatto and Spaniard; and the mestizo, from the Spaniard and Indian. The other subdivisions are as numerous as the possible combinations of the primitive castes. The Indians or native Peruvians are still the most numerous class throughout the country. They present nothing of the fierce and untamed character of the Caribbs or Canadian Indians, but are timid, reserved, and of a melancholy temperament. Much of their apathy and insensibility is unquestionably natural to them, but it has been deepened and rendered more inveterate and habitual by ages of oppression. They are sunk in gross ignorance; but that they are incapable of being roused from their lethargy, and taught the arts of peace and civilization, is a gratuitous absurdity, which several of them have triumphantly refuted by making a distinguished appearance in the pulpit and at the bar. The manufacture of beautiful fabrics is quite common amongst them, and many of the tribes are industrious agriculturists. They have been converted to Christianity; and they have wiped off the reproach of cowardice by their achievements during the war of independence, in which they generally took the part of the royalists. Yet they cherish a deep and mournful impression of the days of the incas; and in all the remote districts of the country the death of the last of the race is annually celebrated by a sort of rude tragedy, accompanied by plaintive and melting strains of music. The mixed races are more numerous than the pure Spaniards, although less so than the native Peruvians. According to Mr Stevenson, the mestizo is strong and swarthy, with very little beard, laborious, and well disposed; the mulatto is less robust, but acute, talkative, imaginative, and fond of dress and parade. In a public disputation at the university, a mulatto in the gallery will often help the embarrassed student out with his syllogism. The zambo, or mulatto and negro, is violent, morose, and stubborn, prone to many vices, and guilty of more robberies and murders than any of the other classes, excepting only the Chinos or negro-Indians, who are said to be the very worst mixed breed in existence; they are ugly, lazy, stupid, and cruel. (R. R. R.)

PERUGIA, a delegation or province of the States of the Church, in Italy, and a part of the ancient Umbria. It is 1793 square miles in extent, and contains seven cities, nineteen market-towns, with numerous villages, and 181,540 inhabitants. It includes a large portion of the Apennines, and is therefore very hilly; but that part through which the Tiber passes is a succession of beautiful and fertile valleys, producing abundance of corn, pulse, fruit, cattle, silk, oil, and wine, besides much honey and wax. The capital is a city of the same name, situated in a rich valley between the Tiber and Lago Perugia, and surrounded by walls and ditches, but not deemed capable of being defended. It is the see of an archbishop, and, besides the cathedral, adorned with the pencil of Peter Perugiano and of Raffaele, contains forty-five parish churches, twenty-four monasteries, twenty-five nunneries, and several charitable institutions; besides a university, which has of late years greatly declined. There are several learned societies, a fine theatre, and some pleasing promenades. In Perugia, though an ancient city, few remains of antiquity are to be seen. The most remarkable of those that remain are the gate of the Grimana Palace, called the arch of Augustus, and the temple of Mars, at the gate of St Angelo. The population is doubtful, some authors stating it at 68,000, whilst Balbi, the latest authority, estimates it only at 30,000. A considerable trade in the raw productions of the fertile soil which surrounds the city centres here; and there are manufactures of silks and velvets, of woollen goods, hats, leather, tartaric acid, brandy, and liqueurs. Many of the private houses are adorned with valuable paintings of the ancient masters. Long. 12. 16. 53. E. Lat. 43. 6. 46. N.

PERUVIANA, a general name sometimes applied to the vast peninsula of South America, extending from the Isthmus of Panama to Cape Horn.

PERUWELS, a market-town of Belgium, in the province of West Flanders, and circle of Tournay. It is situated on the frontier towards France, and contains 5650 inhabitants, employed in making linen, in breweries, and distilleries.

PERWUTTUN, a village on the southern shore of the river Krishna, in a wild tract of almost uninhabited country. Here is a remarkable pagoda, wherein there is an idol, which is shown by the reflected light of a brass speculum, and can only be seen as the flashes fall on it. The pagodas, choultries, and courts, are enclosed by a wall which is covered with a great variety of sculpture. It is 118 miles south from Hyderabad. Long. 78. 40. E. Lat. 15. 57. N.

PESANO, a city of the province of Saluzzo, in the kingdom of Sardinia, in Italy. It is situated on the river Po, and contains 720 houses, with 4600 inhabitants.

PESARO, a city of the pontifical dominions, in Italy, in the delegation of Urbino cum Pesaro. It stands on the river Foglia, at its embouchure, and is surrounded with walls. It is the see of a bishop, and has a cathedral and seven parish churches, with eight monasteries and four nunneries, which have also churches, some of them decorated with paintings from the hands of the best masters. The houses are good, the streets broad; and there is a remarkably fine market-place, with a marble fountain, and a statue of Urban VIII. It contains 13,580 inhabitants, who are occupied in various branches of the silk trade, and in commerce in the raw productions of the vicinity, which are shipped from its small but secure harbour. Long. 12. 48. 16. E. Lat. 45. 51. 1. N.

PESCIA, a city of the duchy of Tuscany, in Italy, the capital of a district, in the province of Florence, of its own name. It is situated on the river Pescia, is the see of a bishop, and has a cathedral and two other churches, with

4200 inhabitants, who subsist chiefly by spinning and weaving silk, and making paper and pottery wares.

PESCINA, a city of Italy, in the province of Principato Ulteriore II. of the kingdom of Naples. It stands on the north-eastern side of the Lake of Cellano, is the see of a bishop, has a cathedral, with several other churches and monasteries, and contains 4500 inhabitants.

PESHAWUR, or PEISHARE, a district and very ancient city of Afghanistan, in the province of Caubul, intersected by the Caubul River, and surrounded on all sides by a mountainous range, by which it is sheltered from the cold winds, and rendered very hot during summer. It is well watered by innumerable streams flowing down the mountains, which are always covered with verdure, produces all sorts of garden-fruits, especially melons, and, with the exception of Cashmere, is considered as the finest province within Afghanistan. It is extremely populous, containing, within a circumference of thirty-five miles, 300,000 inhabitants. The city of Peshawur is large, being upwards of five miles in circumference. The houses are generally built of unburnt bricks in wooden frames, and are mostly three stories in height. The town is intersected by two or three brooks, which run into the Caubul River, and are crossed by bridges. The streets are narrow, but paved, and have a kennel in the middle. The Caubul passes to the north of the city; and the town is adorned with numerous mosques and other edifices, which scarcely merit any particular notice, if we except a caravanserai, and the citadel, which stands on a hill north of the town. This citadel, which is not a place of strength, contains some fine halls, and commands an extensive prospect of the surrounding country, and is adorned with spacious gardens. Few of the houses of the nobility are of any note, but there are some splendid palaces belonging to the king. The inhabitants of this city consist of tribes from all quarters of the East; but the common languages are the Pashtoo and the Hindustanee. The Hazarees, descended from a tribe of Tartars, are the most conspicuous tribe in this city, and still exhibit in their broad faces all the marks of the Tartar physiognomy. Peshawur is an ancient city, and is often mentioned in the histories of the tenth century. In the sixteenth century the city was much improved by Akbar, who, seeing the aversion of the Afghans to commerce and industry, encouraged a number of settlers from the Punjab; and it became a great commercial mart for the trade carried on between Persia, Tartary, and India. It is the residence of many wealthy merchants, especially shawl-dealers; and the markets are abundantly supplied with provisions. This city was visited in 1809 by the Honourable Mountstuart Elphinstone, who was sent as ambassador by the East India Company, and had an audience of Shah Sujah, the Afghan king, who was shortly afterwards defeated by his brother Shah Mahmoud, and obliged to fly. The country has ever since continued the scene of civil war. Long. 70. 37. E. Lat. 33. 32. N.

PEST, or PESTH, a city of the Austrian kingdom of Hungary, the capital of a circle, extending over 4202 square miles, and which comprehends two cities, twenty market-towns, and 319 villages, with 380,000 inhabitants. The city is situated on the left bank of the Danube, opposite to Buda, with which it is connected by a bridge of boats. The town has no walls nor gates, and is defended by a citadel. It is the trading portion of the Hungarian metropolis, and abounds in manufactures of various kinds, though mostly on a small scale. It has a university and several other institutions for education. It contains 3400 houses, and about 60,000 inhabitants. The vicinity is fertile, and produces much good wine. In the early part of 1838, Pest suffered severely from an inundation of the Danube, by which many houses were destroyed, and a great number of individuals lost their lives. Judging from the accounts which have been published, the desolation occasioned by this sudden and resistless outburst of the river must have been truly terrific, and many years will probably elapse before the injury done by the flood can be fully repaired. Long. 25. 57. 12. E. Lat. 47. 31. 40. N.

PETALISM, a mode of deciding on the guilt of citizens, similar to the Athenian ostracism. It was introduced into Syracuse about the year before Christ 460, to restrain the tyranny of the richer citizens, who about that time aimed at the supreme power. To prevent the evils daily arising from this source, and to bring down the aspiring minds of the wealthy citizens, the Syracusans passed a law not unlike that of the Athenian ostracism; for as at Athens every citizen was required to write on a shell the name of the person whom he conceived to be the most likely, on account of his wealth and adherents, to aspire to the crown, so at Syracuse the people were entitled to write on a leaf the names of such as they apprehended powerful enough to usurp the sovereignty. When the leaves were counted, he who had the most suffrages against him was, without any further inquiry, banished for five years. This new method of impairing the consequence and weakening the interest of the overgrown citizens was called *petalism*, from the Greek word πεταλον, which signifies a leaf. But the law in question was attended with many evils; for those who were most capable of governing the commonwealth were banished, and the administration of public affairs was committed to the meanest of the people. Nay, many of the chief citizens, who were able to render their country great service, apprehensive of falling under the penalties of this law, withdrew from the city, and lived privately in the country, not concerning themselves with public affairs; so that all the employments being filled by men of no merit or experience, the republic was reduced to the brink of ruin, and ready to fall into a state of anarchy and confusion. The law of petalism was therefore, on more mature deliberation, repealed soon after it had been first enacted; and the reins of government were again committed to the hands of men who knew how to manage them.

PETALNAIG, a town of Southern Hindustan, in the province of Tinnevelly, a hundred miles north-east from Cape Comorin. Long. 78. 15. E. Lat. 9. 13. N.

PETAREE, a large village of Hindustan, in the province of Malwah, forty-eight miles north-east from Bilsah.

PETAU, DENIS, or DIONYSIUS PETAVIUS, a French Jesuit of great erudition, was born at Orleans in the year 1583. His father, who was a man of learning, observing in his son strong parts and an excellent genius for letters, took every means in his power to improve them. He used to tell his son, that he ought to qualify himself so as to be able to attack and confound the giant of the *Allophylæ;* meaning Joseph Scaliger, whose abilities and learning were allowed to have done much service to the Reformed. Young Petavius seems to have entered readily into his father's views; for he studied most intensely, and afterwards levelled much of his erudition against Scaliger. To the study of the belles lettres he joined that of the mathematics; and afterwards applied himself to a course of philosophy, which he commenced in the college of Orleans, and finished at Paris. He subsequently maintained theses in Greek, which was as familiar to him as Latin; and the Latin, it is said, he understood better than he did his vernacular language. When he was pretty well advanced in his studies, he had free access to the king's library, which he often visited on account of the Latin and Greek manuscripts. Amongst other advantages which attended his literary pursuits, may be reckoned the friendship of Isaac Casaubon, whom Henry IV. called to Paris in 1600. It was at Casaubon's instigation that Petavius, though then very young, undertook an edition of the works of Synesius, in which he corrected the Greek from the manuscripts, translated what yet remained to be translated into Latin, and wrote notes upon the whole.

He was only nineteen years of age when he was made professor of philosophy in the university of Bourges; and he spent the two following years in studying the ancient philosophers and mathematicians. In 1604, when Morel, professor of Greek at Paris, published the works of St Chrysostom, some part of Petavius's labours on Synesius were added to them; and from the title we learn, that he then took the name of *Pætus*, which he afterwards changed into *Petavius*. His own edition of the works of Synesius did not appear till the year 1612.

He entered into the society of the Jesuits in 1605, and did great credit to it by his extensive and profound erudition. He became a zealous advocate of the Church of Rome; and there was no way of serving it more agreeable to him than that of criticising and assailing its adversaries. He was very bitter against Scaliger; nor did he even spare his friend Casaubon whenever the latter came in his way. Petavius excelled particularly in chronology; the learned world in general being indebted to him for some exact and nice disquisitions on this subject. His principal work, which is entitled *Rationarium Temporum*, is an abridgment of universal history, from the earliest times till the year 1632, arranged in chronological order, with references to proper authorities; and it was improved by Perizonius and others, who made several additions to it after his death. This eminent father, after a very laborious life, died at Paris about the close of the year 1652, aged sixty-nine.

PETCHELEE, a considerable and extensive province of China, in which Peking, the capital, is situated. Being one of the northerly provinces of China, its climate is cold, and the winter is severe, all the rivers being frozen during four months in the year, from November to March. It is in general of a sandy soil; a great part of it is a dead flat, and the sea-coast is bordered with extensive marshes. To the north the country is elevated, and rises into that range of lofty mountains along which the great wall is conducted. The country is not favourable for the production of rice; but it is well fitted for wheat, barley, and the other grains of the temperate climates. The principal river is the Peiho, which rises within the Tartar frontier, and, after passing Peking, discharges itself into the Yellow Sea, or Gulf of Petchelee. By means of this sea a considerable trade is carried on with Corea and Japan. But this province is chiefly indebted for its prosperity to the communications established between its rivers and the Imperial Canal, which affords a navigable communication across the whole empire. The population is estimated at 38,000,000.

PETER (originally *Simeon* or *Simon*, שמעון, called also, by a rendering of the Greek Πετρος into the corresponding word in the Aramaic dialect spoken in Palestine in the days of our Lord, *Cephas*, כיפא, John, i. 42), one of the twelve apostles, and author of two epistles in the inspired canon. He was a native of Bethsaida in Galilee, and was the son of a certain Jonas, or John, whence he is named on one occasion in the gospel history Simon Barjona, that is, son of Jona (Matt. xvi. 17). Along with his brother Andrew, he followed the occupation of a fisherman on the Sea of Galilee. It is probable that before they became known to Christ they were both disciples of John the Baptist. That Andrew was so, we are expressly informed by the evangelist John; and as his brother seems to have been much of the same mind with him on religious matters, it is extremely likely that he was so likewise. Their becoming known to Christ was owing to John's pointing him out on the day after his baptism to Andrew and another disciple (probably the evangelist John), as "the Lamb of God," on which they immediately followed Christ, and spent some time in receiving his instructions. Shortly after this, Andrew finding Simon, carried him to Christ, who, on receiving him as his disciple, bestowed upon him that surname by which he has since that time been most commonly designated: "When Jesus beheld him he said, thou art Simon the son of Jona; thou shalt be called Cephas, which is by interpretation a stone (πετρος)." After this interview the two brothers seem to have returned to their usual occupation for a season, as we have an account in Matthew (iv. 18–20), of their being summoned from that occupation by Christ on a subsequent occasion, posterior to his temptation in the wilderness, and to the commencement of his public ministry as a religious teacher. From this time forward they were his devoted and admiring followers. In the course of the evangelical history several anecdotes of Peter are incidentally recorded, for the purpose, doubtless, principally of illustrating the character and teaching of our Lord, but which tend also to throw light upon the history and character of his attached disciple. Such are the accounts furnished by the evangelists of his walking upon the agitated waters of the Sea of Galilee to meet his master (Matthew, xiv. 22, ff.; Mark, vi. 45, ff.); of his bold and intelligent avowals of the undoubted Messiahship of Jesus, notwithstanding the difficulties which he, along with the rest of the disciples, felt in reconciling what they saw in him with what they had fondly expected the Christ to be (Matthew, xvi. 13–20); of his rash but affectionate rebuke of his Lord for speaking of suffering and death as in prospect for him, and as forming a necessary part of his mediatorial work (Matthew, xvi. 21–23); of his conduct in first rejecting, with an earnestness bordering on horror, the offer of Christ to wash his feet, and then, when the symbolical nature of that act had been explained to him, his over-ardent zeal that not his feet only, but also his hands and his head, might be washed (John, xiii. 4, ff.); of his bold and somewhat vaunting avowal of attachment to his Master, and his determination never to forsake him, followed by his disgraceful denial of Jesus in the hour of trial (John, xiii. 36, 37; Mark, xiv. 29, &c.); of his deep and poignant contrition for this sin (Matthew, xiv. 72); and of his Lord's ample forgiveness of his offence, after he had received from him a profession of attachment as strong and as frequently repeated as his former denial of him (John, xxi. 15–18). From these notices it is easy to gather a tolerably correct conception of the predominating features of the apostle's character up to this period. He seems to have been a man of undoubted piety, of ardent attachment to his Master, and of great zeal for what he deemed his Master's honour, but at the same time with a mind rather quick than accurate in its apprehensions, and with feelings rather hasty in their impulse than determined and continuous in their exercise. Hence his readiness in avowing his opinions, and his rashness in forming them; and hence also the tendency which beset his honest openness to degenerate into bravado, and his determinations of valour to evaporate into cowardice at appalling forms of danger. His fall, however, and his subsequent restoration, connected as these were with the mysterious events of his Master's crucifixion and resurrection, and with the new light which had by them been cast around his character and work, produced a powerful change for the better upon the apostle's mind. From this time forward he comes before us under a new aspect. A sober dignity and firmness of purpose have displaced his former hasty zeal; sagacity and prudence characterize his conduct; and whilst his love to his Master shows no symptom of abatement, it displays itself rather in active labour and much-enduring patience in his service, than in loud protestations or extravagant exhibitions of attachment. In the subsequent Scripture history he is presented to us as the courageous herald of the kingdom of Christ, by whose mouth the first public declaration of salvation through the crucified Jesus was made to the people; by whose advice and counsel the early churches were planted and governed; and by whom the prejudices of Judaism were first fairly surmounted, and the gospel preached in all its universal freeness to the Gentile world.

The Acts of the Apostles contain recitals of many interesting incidents which befell him whilst engaged in those efforts. Of these, the chief are his imprisonment and trial before the Sanhedrim, for preaching Christ, and his bold avowal of his determination to persist in that work (Acts, iv. 1–22); his miraculously inflicting the punishment of death on the infatuated couple who had dared to try an experiment upon the omniscience of the Holy Ghost (v. 1–11); his visit to Samaria, and rebuke of Simon Magus, who deemed that the miracles of the apostle were the work of some deep magic spell of which he had not yet become possessed, and which consequently he was desirous of purchasing from Peter (viii. 14–24); the vision by which he was taught that the ancient ritual distinctions between clean and unclean had been abolished, and thereby prepared to attend on the summons of Cornelius, to whom he preached the gospel (x. 1–48); his apprehension by Herod Agrippa, and his deliverance by the interposition of an angel, who opened for him the doors of his prison, and set him free (xii. 3–19); and his address to the council at Jerusalem, on the occasion of a request for advice and direction being sent to the church there by the church in Antioch, in which he advocated the exemption of Gentile converts from the ceremonial institutes of the law of Moses (xv. 6–11). In all these incidents we trace the evidences of his mind having undergone an entire change, both as to its views of truth and impressions of duty, from what is displayed by the earlier events of his history. On one occasion only do we detect something of his former weakness, and that strangely enough in regard to a matter in which he had been the first of the apostles to perceive, and the first to recommend and follow, a correct course of procedure. The occasion referred to was his withdrawing, through dread of the censures of his Jewish brethren, from the Gentiles at Antioch, after having lived in free and friendly intercourse with them, and his timidly dissembling his convictions as to the religious equality of Jew and Gentile. For this Paul withstood him to the face, and rebuked him sharply, because of the injury which his conduct was calculated to produce to the cause of Christianity. With this single exception, however, his conduct seems to have been in full accordance with the name which his Master had prophetically bestowed on him when he called him Simon the Rock, and with the position which Paul himself assigns to him, at the very time that he recounts his temporary dereliction, as one of the "Pillars of the Church."[1]

Thus far we are enabled, from the inspired documents, to trace the history of this apostle; but for what remains we must be indebted to evidence of a less explicit and certain character. The testimony of several of the ecclesiastical writers, corroborated by the phraseology employed by the apostle himself in the salutation of his first epistle, makes it highly probable that at some period of his official life he performed an extensive missionary tour throughout those districts, to the converts in which his epistles were addressed. "It appears," says Origen, "that Peter preached to the Jews in the dispersion, in Pontus, Galatia, Bithynia, Cappadocia, and Asia."[2] A less certain tradition reports the apostle as having towards the close of his life visited Rome, become bishop of the church in that city, and suffered martyrdom in the persecution raised against the Christians by Nero. The importance of these points in connection with the claims urged by the Catholics on behalf of the supremacy of the pope, has led to a careful and sifting examination of the accuracy of this tradition; the result of which seems to be, that whilst it is admitted as certain that Peter suffered martyrdom, in all probability by crucifixion,[3] and as probable that this took place at Rome, it has, nevertheless, been made pretty clear that he never was for any length of time resident in that city, and morally certain that he never was bishop of the church there.[4] By some an attempt has been made to obtain the support of the apostle's own testimony in favour of his having at one period resided at Rome, by interpreting the words, "the church that is at *Babylon*," the salutations of which he sends to those to whom he wrote his first epistle, as applying to the church at *Rome*; an attempt which Dr Campbell justly stigmatizes as "poor, not to call it ridiculous." Even if we admit that at the time when this epistle was written it was understood amongst the Christians that Babylon was the prophetical name for Rome, an admission, however, which is entirely unsupported by evidence, it would remain unexplained why the apostle, in such a mere matter-of-fact affair as the communication of the friendly salutations of one church to another, should have employed the obscure and symbolical language of prophecy, when his meaning could have been so much more distinctly conveyed by a simple statement. This would be the more inexplicable, that the style of Peter is remarkably plain and perspicuous throughout the entire epistle. It seems much more consistent, therefore, with rational principles of interpretation, to understand the statement literally of Babylon in Egypt, in which city, as we learn from Josephus, there was a great multitude of Jews (ἐνθα ϰαι πληθος ἠν Ἰουδαιων, *Ant. Jud.* l. xv. c. ii. sect. 2; see also c. iii. sect. 1), and to which, consequently, it is almost certain, that at some period of his life, "the apostle of the circumcision" (Gal. ii. 8) must have paid a visit.

The assertion that St Peter was bishop of Rome is connected with another by which the claims of the papacy are sought to be established, namely, that to him was conceded a right of supremacy over the other apostles. In support of this, an appeal is made to those passages in the gospels, where declarations supposed to imply the bestowal of peculiar honour and distinction on Peter are recorded as having been addressed to him by our Lord. The most important of these are, "Thou art Peter, and on this rock will I build my church" (Matt. xvi. 18); and, "Unto thee will I give the keys of the kingdom of heaven," &c. (Matt. xvi. 19). At first sight these passages would seem to bear out the assumption founded on them; but upon a more careful investigation it will be seen that this is rather in appearance than in reality. The force of both is greatly impaired for the purpose for which Catholics produce them, by the circumstance, that whatever of power or authority they may be supposed to confer upon Peter, must be regarded as shared by him with the other apostles, inasmuch as to them also are ascribed in other passages the same qualities and powers which are promised to Peter in those under consideration. If by the former of these passages we are to understand that the church is built upon Peter, the Apostle Paul informs us that it is not in him *alone* that it is built, but upon *all* the apostles (Ephes. ii. 20); and in the book of Revelation we are told, that on the twelve foundations of the New Jerusalem (the Christian church), are inscribed

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[1] Gal. ii. 9–14. The circumstance of Peter's having submitted to a rebuke from Paul is so fatal to the pretensions which have been urged in favour of his supremacy over the other apostles, that from a very early age attempts have been made to set aside its force, by the hypothesis that it is not of Peter the apostle, but of another person of the same name, that Paul speaks in the passage referred to; *Conf.* Euseb. *H. E.* i. 13. This hypothesis, however, is so plainly contradicted by the words of Paul, who explicitly ascribes apostleship to the Peter of whom he writes, that it is astonishing how it could have been admitted even by the most blinded zealot. See ver. 8, 9.

[2] *In Genesin*, lib. iii. ap.; Euseb. *H. E.* iii. 1. See also Euseb. iii. 4.

[3] "Petrus passioni Dominicæ adæquatur." (Tertull. *De Præscrip.* 38.) See also Lactant. *De Mortibus Persec.* c. ii.

[4] See Barrow's Treatise on the Pope's Supremacy; Works by Hughes, vol. vii. p. 207, ff.; Campbell's Lectures on Eccl. Hist. lect. xii.; Neander's *Geschichte der Pflanzung und Leitung der Christ. Kirche*, bd. ii. s. 311–15; Winer's *Biblisches Realwörterbuch in Petrus*, &c.

St Peter.

"the names of the *twelve apostles of the Lamb*" (ch. xxi. 14). As for the declaration in the latter of these passages, it was in all its essential parts repeated by our Lord to the other disciples immediately before his passion, as announcing a privilege which, as his apostles, they were to possess in common (Matt. xviii. 18; John, xx. 23). It is, moreover, uncertain in what sense our Lord used the language in question. In both cases his words are metaphorical; and nothing can be more unsafe than to build a theological dogma upon language of which the meaning is not clear, and to which, from the earliest ages, different interpretations have been affixed. And, finally, even granting the correctness of that interpretation which Catholics put upon these verses, it will not bear out the conclusion they would deduce from them, inasmuch as the judicial supremacy of Peter over the other apostles does not necessarily follow from his possessing authority over the church. On the other side it is certain, that there is no instance on record of the apostle's having ever claimed or exercised this supposed power; but, on the contrary, he is oftener than once represented as submitting to an exercise of power upon the part of others, as when, for instance, he went forth as a messenger from the apostles assembled in Jerusalem to the Christians in Samaria (Acts, viii. 14), and when he received a rebuke from St Paul, as already noticed. Whilst, however, it is pretty well established that Peter enjoyed no judicial supremacy over the other apostles, it would, perhaps, be going too far to affirm that no dignity or primacy whatsoever was conceded to him on the part of his brethren. His superiority in point of age, his distinguished personal excellence, his reputation and success as a teacher of Christianity, and the prominent part which he had ever taken in his Master's affairs, both before his death and after his ascension, furnished sufficient grounds for his being raised to a position of respect and of moral influence in the church and amongst his brother apostles. To this some countenance is given by the circumstances that he is called "the first," πρωτος, by Matthew (ch. x. 2), and that apparently not merely as a numerical, but as an honorary distinction; that when the apostles are mentioned as a body, it is frequently by the phrase, "Peter and the eleven," or, "Peter and the rest of the apostles," or something similar; and that when Paul went up to Jerusalem by divine revelation, it was to Peter particularly that the visit was paid. These circumstances, taken in connection with the prevalent voice of Christian antiquity, would seem to authorize the opinion that Peter occupied some such position as that of προεστως, or president in the apostolical college, but without any power or authority of a personal kind over his brother apostles.[1]

The extant writings of the apostle Peter are confined to two brief epistles, of which the former has been universally admitted as genuine, whilst the latter has by many been rejected as spurious. The grounds of this rejection, however, are extremely insecure, as they depend chiefly upon nice distinctions and analogies of style between the two epistles, which are seldom drawn with such unerring accuracy as to induce us to attach very much weight to them.[2] The persons to whom these epistles were addressed were converted Jews scattered over the districts enumerated by the apostle in the commencement of the first of them. The epistles themselves are characterized by great vigour of conception, warmth of feeling, and force of eloquence. The style is glowing and rapid, approaching at times to vehemence; and the sentiments are of the most elevated description. The exhortation to holiness with which the second chapter of the first epistle concludes, is perhaps unequalled in the New Testament for the appropriateness of its sentiments, the beauty of its appeals, and the concentred energy and rapid flow of the style; nor would it be easy to find any passage, either in sacred or profane literature, that should surpass in vividness of description and power of expression the prophetic view of the end of the world with which, towards the conclusion of the second epistle, he enforces his exhortation to holy conversation and godliness. In both epistles we trace the characteristic ardour and the elevated piety of their author, and of both we may justly say, in the language of the excellent Leighton, that they are eminently adapted "to establish Christians in believing, to direct them in doing, and to comfort them in suffering, often setting before them the matchless example of the Lord Jesus, and the greatness of their engagement to follow him." (N. N. N. N.)

Peter *of Blois*, a learned man of the twelfth century, was born about the year 1120, at the city of Blois, in France, from which he derived his name. His parents being opulent, gave him a learned education. In his youth, when he studied in the university of Paris, he was excessively fond of poetry; and when he had advanced a little further in life, he became no less fond of rhetoric, to the study of which he applied with the greatest ardour. From Paris he removed to Bologna in Italy, to study the civil and the canon law, in the knowledge of which he very much excelled. From his writings it appears that he cultivated medicine, and several branches of the mathematics, with no little care and success. But the study of theology formed the chief delight and business of his life, and in it he not only spent the greatest part of his time, but made the greatest progress. Unfortunately, however, the theology he studied was of that scholastic kind, which consisted in vain attempts to explain and prove the many absurd opinions which then prevailed, by the subtilties of the Aristotelian logic. In attempting to explain the doctrine of the real presence, as held by the Latin church, he was the first who employed the famous term *transubstantiation*, which was soon afterwards adopted by the church, and has ever since been retained. Being appointed preceptor to William II. king of Sicily, in 1167, he obtained the custody of the privy seal; and, next to the Archbishop of Palermo, who was the prime minister, he had the greatest influence in all affairs. His power, however, was not of long duration; for the archbishop being banished in 1168, Peter soon afterwards left the court of Sicily, and returned into France. But in a short time he found another royal patron, having been invited into England by Henry II. who employed him as his private secretary, made him Archdeacon of Bath, and gave him some other benefices. Having spent a few years at court, however, he conceived a disgust at that way of life, of which in one of his letters he has drawn a very unpleasing picture, and retired into the family of Richard, archbishop of Canterbury, who had made him his chancellor about the year 1176. In this station he continued until the death of the archbishop in 1183, enjoying the highest degree of favour with that prelate, though he used much freedom in reproving him for his remissness in the government of the church. He continued in the same station in the family of Archbishop Baldwin, who succeeded Richard, acting both as his secretary and as his chancellor. In 1187, he was also sent by the latter prelate upon an embassy to Rome, to plead his cause before Urban III. in the famous controversy between him and the monks of Canterbury respecting the church of Hackington. After the departure of his friend and patron Baldwin for the Holy Land in the year 1190, our author was in his old age involved in various troubles, the causes of which are not distinctly known; and he died about the end of the twelfth century. He appears from his works, which may be justly reckoned amongst the most valuable monuments of the age in which he flourished, to have been a man of great integrity and sincere piety, as well as of a lively, inventive genius, and uncommon erudition. His printed works consist of a hundred and thirty-four letters, which he collected together at the desire of Henry II.; of sixty-five sermons, delivered on various occasions; and of seventeen tracts on different subjects.

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[1] Campbell's Eccl. Hist. lect. v. and xii. Barrow's Treatise, *ut sup.* Works, vol. vii. p. 144, ff. &c.

[2] Horne's Introduction, vol. iv. p. 434, ff.; Sherlock's Dissertation on the Second Epistle of Peter.

Peter I, czar or tsar, and afterwards emperor, of Russia, was the founder of the Russian empire. That country was indeed well known, and of great antiquity; but it had no extent of power, of political influence, or of general commerce in Europe, until the time of Peter. He was born in 1672, and proclaimed czar when only ten years of age, in exclusion of John his eldest brother, who, being of a sickly constitution, was at the same time equally deficient in understanding. The Princess Sophia, his sister by the half-blood, raised an insurrection in favour of John; but, to put an end to the civil war, it was at last agreed that the two brothers should jointly share the imperial dignity. Peter had been very ill brought up, not only through the general defects of education in Russia, but likewise through the arts of the Princess Sophia, who surrounded him with every thing calculated to stifle his natural desire of knowledge and to deprave his mind. But notwithstanding this, his inclination for military exercises discovered itself in his tenderest years. He formed a company of fifty men, commanded by foreign officers, and clothed and exercised after the German manner. He himself entered into the lowest post, that of a drummer, and never rose otherwise than as a soldier of fortune. His design in this was to teach his nobility, that merit, and not birth, formed the only solid title to military employments. He reinforced his company with several others, until at last he had got together a considerable body of soldiers. As he had then no war on his hands, he exercised them in all sorts of mock engagements, and by this means secured to himself a body of well-disciplined troops. The sight of a Dutch vessel, which he had met with upon a lake belonging to one of his pleasure-houses, made such an impression on his mind, that he conceived the almost impracticable design of forming a navy. His first care was to get some Hollanders to build small vessels at Moscow; and he passed two successive summers on board of English or Dutch ships, which sailed out from Archangel, that he might instruct himself in every branch of nautical affairs. In the year 1696, the Czar John died, and Peter now became sole master of the empire. In 1698 he sent an embassy to Holland, and having gone *incognito* in the retinue, he visited England as well as Holland, to inform himself fully respecting the art of ship-building. At Amsterdam he worked in the yard as a private ship-carpenter, under the name of Peter Michaelof; but he has been often heard to say, that if he had never gone to England, he would still have remained ignorant of the art of ship-building. In 1700 he had got together a body of regular troops, amounting to thirty thousand infantry; and now the vast project he had formed displayed itself in all its parts. He opened his dominions, which till then had been closed, having first sent the principal nobility of his empire into foreign countries to improve themselves in knowledge and in learning. He invited to Russia all the foreigners he could meet with, who were capable of instructing his subjects in any respect, and offered them great encouragement to settle in his dominions. This raised many discontents; and the despotical authority which he exerted on all such occasions was scarcely sufficient to suppress them. In 1700, being strengthened by the alliance of Augustus king of Poland, he made war on Charles XII. king of Sweden. His ill success at first did not discourage him; for he used to say, "I know that my armies must be overcome for a great while; but even this will at last teach them to conquer." He afterwards gained considerable advantages, and founded St Petersburg in 1703. In 1709 he gained a complete victory over the Swedes at Pultowa. In 1712 he was surrounded by the Turks on the banks of the Pruth, and seemed inevitably lost, had not the Czarina Catherine bribed the grand vizier, and the czar's prudence completed his deliverance. In 1716 he made a tour through Germany and Holland, and visited the Royal Academy of Sciences at Paris. It would be endless to enumerate all the various establishments for which the Russians are indebted to him. He formed an army according to the tactics of the most experienced nations; he fitted out fleets in all the four seas which border upon Russia; he caused many strong fortresses to be raised according to the best plans, and made convenient harbours; he introduced arts and sciences into his dominions, and freed religion from many superstitious abuses; he made laws, built cities, cut canals, and executed many other works; he was generous in rewarding, and impartial in punishing; faithful, laborious, and humble, yet not free from a certain roughness of temper natural to his countrymen. He had indeed cured himself of excess in drinking; but he has been branded with several other vices, particularly cruelty. He published the unfortunate history of his son Prince Alexis, towards whom some blame his severity, whilst others think it no greater than was absolutely necessary. He perfectly knew the respect due to persons of merit; and not only heaped honours upon them during their life, but paid to their memory marks of esteem after their death. He died of the strangury in 1725, and is said to have left the world with the magnanimity of a hero and the piety of a Christian.

Peter *the Wild Boy*. This extraordinary creature at one time occasioned a great deal of speculation amongst the learned; but we do not know that any satisfactory causes have been assigned for the striking difference observed between him and other human beings.

The following account of him is extracted from the parish register of North Church, in the county of Hertford. "Peter, commonly known by the name of *Peter the Wild Boy*, lies buried in this church-yard, opposite to the porch. In the year 1725 he was found in the woods near Hamelen, a fortified town in the electorate of Hanover, when his majesty George I. with his attendants, was hunting in the forest of Hertswold. He was supposed to be then about twelve years of age, and had subsisted in those woods upon the bark of trees, leaves, berries, &c. for some considerable length of time. How long he had continued in that wild state is altogether uncertain; but that he had formerly been under the care of some person, was evident from the remains of a shirt collar about his neck at the time when he was found. As Hamelen was a town where criminals were confined to work upon the fortifications, it was then conjectured at Hanover that Peter might be the issue of one of those criminals, who had either wandered into the woods and could not find his way back again, or, being discovered to be an idiot, was inhumanly turned out by his parents, and left to perish, or shift for himself. In the following year, 1726, he was brought over to England, by the order of Queen Caroline, then Princess of Wales, and put under the care of Dr Arbuthnot, with proper masters to attend him. But notwithstanding there appeared to be no natural defect in his organs of speech, after all the pains that had been taken with him he could never be brought distinctly to articulate a single syllable, and proved totally incapable of receiving any instruction. He was afterwards intrusted to the care of Mrs Titchbourn, one of the queen's bedchamber women, with a handsome pension annexed to the charge. Mrs Titchbourn usually spending a few weeks every summer at the house of Mr James Fenn, a yeoman farmer at Axter's End, in this parish, Peter was left to the care of the said Mr Fenn, who was allowed thirty-five pounds a year for his support and maintenance. After the death of James Fenn he was transferred to the care of his brother Thomas Fenn, at another farm-house in this parish, called Broadway, where he lived with the several successive tenants of that farm, and with the same provision allowed by government, to the time of his death, 22d of February 1785, when he was supposed to be about seventy-two years of age."

Peter's Pence, the name applied to an annual tribute of one penny, paid at Rome by every family at the festival of St Peter. Ina the Saxon king, when he went in pilgrimage to Rome about the year 740, paid this contribution to the pope, partly as alms and partly in recompense of a house erected in Rome for English pilgrims; and the same continued to be paid generally until the time of Henry VIII., when it was enacted, that henceforth no person should pay any pensions, Peter's pence, or other impositions, for the use of the bishop or see of Rome.

PETERBOROUGH, one of the smallest English cities, situated in a corner of the county of Northampton, on the confines of Huntingdonshire, seventy-nine miles from London. The city is by the new municipal law governed by a mayor, with four aldermen and twelve councillors, and returns to parliament two members, who are chosen by householders, most of whose dwellings are the property of the Earl Fitzwilliam, who consequently has a preponderating influence in the elections. The buildings are moderately handsome. There is a well-supplied market, which is held on each Saturday; but though provisions are cheap, it is not populous, and, from the vicinity to the fens, is generally deemed unhealthy. The population amounted in 1801 to 3449, in 1811 to 3674, in 1821 to 4598, and in 1831 to 5553.

The most interesting object in the city is the ancient abbey, converted into a cathedral at the time when this place was created the see of a bishop by King Henry VIII. This ancient edifice was spared at the general destruction of the religious buildings, because, as is commonly believed, it had been the place of interment of Catherine of Aragon. It was at the time of the suppression a very rich establishment, and only a small portion of the revenues was applied to form the chapter, which, besides the bishop, consisted of a dean, six prebendaries, a divinity reader, eight minor canons, and the same number of lay clerks and singing men. The present edifice was begun in the year 1117, but not finished till the year 1143. It had some additions made to it in the year 1177. Between the years 1200 and 1222 it was improved by the addition of glass windows. After the Reformation, it suffered much from the democratic party; but, in its present state, it exhibits some fine specimens of the architecture of remote ages. This church has one advantage over most of the other cathedrals, that it is less encumbered with surrounding buildings. The precincts are entered from the town under a Gothic archway, when the most imposing part of the building is at once displayed to the view; we mean the west front, to which there is nothing in Gothic architecture in England that will bear a comparison, except the west front of Wells Cathedral, and that of Rheims in France, both of which, though equal in extent, are far inferior to it in form, proportions, and general effect. There is a solemnity in the effect which it produces, observable in no other cathedral, and which is not unmixed with awe. There are other parts of this edifice much admired, such as the beautiful building which surrounds the choir, the central tower or lanthorn, the ceiling of the nave, the organ-screen, and the cloisters. The whole of this edifice has been beautified, improved, and ornamented, by the liberality of Dr Monk, now bishop of Gloucester.

The dimensions of the cathedral are as follow: The breadth of the western façade is a hundred and fifty-six feet; the length of the nave from the western wall to the entrance of the choir is two hundred and six feet, the breadth of it being thirty-five feet; the length of the transept is a hundred and eighty-four feet; and the length of the choir, from the entrance to the eastern extremity, is a hundred and twenty-eight feet. The total external length of the cathedral is four hundred and seventy-nine feet; the general height, from the pavement to the ceiling, is eighty-one feet, and to the top of the lanthorn a hundred and thirty-five feet.

The income of the bishopric is not large. In the king's books it is charged at L.4141. 7s. 8d. per annum; but the gross value, according to the parliamentary return made by the bishop, is no more than L.3518. By the recent law it is to be augmented by the application of a portion of the revenue of the see of Ely; and, by the same law, the archdeaconry of Leicester is placed under the episcopal jurisdiction of the bishop of Peterborough.

PETERHEAD, a parish of Scotland, situated on the east coast, in latitude 57. 34. N. and longitude 1. 35. W. in the district of Buchan, and county of Aberdeen. It extends along the coast in a straight line about four miles, bending along the sea-shore about five miles; and from east to west it extends from three to four miles. The surface is nearly level along the coast. The Stirlinghill and Blackhill, containing extensive quarries of granite, are on the southern and western boundaries. The surface of the parish extends to upwards of 9000 imperial acres, of which about 8300 are under cultivation, 72 are planted, 500 are capable of cultivation, and the remainder is chiefly rocky. Extensive improvements in the cultivation of the soil have been made within the last thirty years. The rental of the landward part of the parish is about L.10,000. The population amounts to 7867.

Peterhead, a burgh in the parish of the same name, in the county of Aberdeen, is situated upon the most easterly point of the mainland of Scotland. Previously to 1593 it was a small fishing village. In that year it was erected into a burgh of barony by George, earl marischal. It was forfeited in 1715, and purchased by the York Building Company, from whom the present proprietors, the governors of the Maiden Hospital founded by the company of merchants of the city of Edinburgh, and Mary Erskine, acquired it by purchase in 1728. The superiors had the nomination of the magistrates until the passing of the burgh reform act in 1832, by which the municipal government has been vested in twelve councillors, who from their own number choose a provost, three bailies, and a treasurer. The town contains about 1000 inhabited houses, besides warehouses, and the rental is about L.7500. The boundaries of the town have been considerably enlarged under the burgh reform act, and now embrace the village of Buchanhaven, and part of the lands of Invernettie.

The harbours of Peterhead are extensive; and, from their peculiar position at the termination of the most easterly promontory of land in Scotland, having an entrance both from the south and north, and being about equally distant from the Friths of Forth and Moray, much resorted to by vessels frequenting the east coast of Scotland, and affording, as they do, shelter and protection, not only to the trade of the port, but also to shipping in general frequenting the east coast of Scotland, they deserve attention in a national point of view. About L.47,000 have been expended in building these harbours. They are managed by commissioners incorporated by act of parliament, and yield an annual revenue of about L.2800. The south harbour embraces an area of 6·16 imperial acres, having from twelve to fourteen feet water at medium springs, and from eight to ten feet at neap-tides. The north harbour, which has an area of 10·86 imperial acres, has at spring-tides eighteen feet water, and never under fourteen feet on any tide. The quays extend to about 3350 feet in length. Connected with the harbours there is an excellent graving-dock. The shipping belonging to the port amount to about 13,000 tons. The number of vessels which annually take shelter in the harbours may be stated on an average at 240. The leading articles of export are grain, meal, eggs, butter, cattle, fish, and the produce of the fisheries. The imports are groceries, clothiery, flour, salt, iron, timber, coal, lime, bone manure, &c. An extensive trade to Greenland and Davis' Straits has been carried on from Peterhead with various success since the year 1788. During that time 3020 whales have been caught, which have yielded 30,296 tons of oil. The herring fishery has of late been carried on with great success. In 1837, 262 boats were employed in this fishery, and upwards of 40,000 barrels of herrings were caught. It is supposed that Peterhead, being situated farther east than any other land in Scotland, must at all times be one of the best stations for carrying on the herring fishery, as, if the herrings pass along the coast, they must pass near to this headland, and as the tides are strong, only the best fish can make head against them; and, in fact, it has been found that those caught at Peterhead are of superior quality. The lighthouse, which stands on the Buchan-ness, at the extremity of the south bay, is of the utmost importance, both as regards the interests of the general trade of the port, and the prosecution of the herring-fishery. A considerable trade is occasionally carried on in granite from the quarries in the neighbourhood. The stone, which is generally of the red granite, and of excellent quality, may be raised in large blocks. The pillars in the British Museum, the docks at Sheerness, the pillar erected in London to the memory of the late Duke of York, and many other public works, have been built of granite from Peterhead.

In former times Peterhead was much resorted to as a watering-place; and as it certainly possesses many advantages to the invalid who requires sea-bathing and the tonic effects of the mineral waters, it held a high rank amongst the places of summer retreat for upwards of two centuries. Perhaps no place in the island is more suitable for those whose cases require the bracing effects of sea-bathing or sea-air; the former, from the rapidity of the tides and the absence of rivers, being to be enjoyed in the greatest possible perfection; and the latter, from the almost insular situation of the place, and the total absence of all muddy or marshy exhalations, or other sources of contamination, affording all the advantages without the inconvenience of a sea-voyage. In many cases much benefit may also be derived from the use of the chalybeate waters with which the neighbourhood abounds. But perhaps the renovated health and spirits which are in most cases the result of a season at Peterhead are mainly to be attributed to the air and bathing, together with the regular hours and habits which such a residence naturally inculcates.

The town is plentifully supplied with excellent spring-water, which within the last few years has been brought at a great expense for the use of the inhabitants and the shipping; and it is now lighted with gas. There are no manufactures of woollen or cotton goods in Peterhead, although, from its situation, there is every reason to believe that such manufactures might be carried on with advantage.

The places of worship are, the original parish church, the East parish church or chapel of ease, the Episcopal chapel, and the United Session, Congregational, and Methodist meeting-houses. In the town there is a news-room, and also a reading society, who have a large and valuable library; and there have lately been established an association for the promotion of science, literature, &c. and a mechanics' institution. There is a weekly market, which is held on Friday; and there are two annual fairs, viz. on the third Tuesday in May and the second Tuesday in November, both old style.

Petersburg.

Of late years the town has very much increased, both in inhabitants and in trade and shipping. The inhabitants are intelligent and industrious, and therefore there is reason to anticipate the future extension and prosperity of the burgh. The population of the town in 1838 amounted to 6200. The number of qualified electors was 211.

PETERSBURG, St, a city, in the most northern situation of any large place in the globe, its observatory being in latitude 59. 56. 13. N., and in longitude 30. 17. 33. E. It was almost from its origin the second, and has of late become the first city of the Russian empire; its population having in the course of the last few years exceeded that of Moscow by more than 100,000 inhabitants, being at the close of 1836, including the military, 499,000.

The origin of most of the other European capitals dates from a period so remote that the date of their foundation is a matter of doubt and a subject of controversy; but St Petersburg is a comparatively modern city, having been raised to consideration almost instantaneously, and in little more than a century having attained its present extent. It is situated in what formed a part of the Swedish province of Ingria, or Ingemannland, till, in consequence of the victory of Embach in January 1702, gained by the Russians over the Swedes, and the peace which followed it, the territory was obtained by the former, then under the sway of the Czar, afterwards the Emperor Peter, better known by the distinguishing title of Peter the Great.

Peter, soon after his accession to power, had felt the importance of communication with foreign lands as the means of introducing civilization amongst the rude and barbarous people over whom he ruled, and consequently began to direct his attention to maritime affairs. As early as 1693, Archangel was his chief northern port; but he soon afterwards looked towards the southern part of his dominions, and constructed an arsenal on the river Don, at Woronesh, where he built a sufficient number of armed vessels to secure to himself a superiority on that river, and the safe access to the Sea of Asof, which was accomplished by the year 1696. He had become so attached to affairs of a maritime nature, that the year after, in order to qualify himself to conduct them properly, he resolved to visit the western shores of Europe, and, as a real workman, to become familiar with the whole process of building, equipping, arming, and fighting a fleet of ships of war.

He spent much time in Holland working in the ship-yards, and some time in the dock-yard at Deptford, whence he frequently, in his working dress, visited King William at Windsor, and once went to Oxford, where a doctor's degree was conferred upon him. During his residence in England and Holland he engaged to repair with him to Russia more than five hundred persons, consisting of military and naval officers, engineers, surgeons, and artificers of various kinds. He was recalled home by an insurrection, which was soon suppressed, and the participators in which were dreadfully punished. A war then broke out with Sweden, in which he was at first unsuccessful, until his army had learned of their enemies to conquer them. The result of that war was the possession of that spot of Finland where the river Neva runs from the Lake of Ladoga into the Baltic Sea.

When Peter had thus gained the district, his first intention was merely to erect a strong fortress, the foundation of which was laid on the 27th of May 1703, and more than 20,000 men were collected at the spot to execute the work. Whilst this work was proceeding, a thought struck Peter that this would be the most appropriate spot for the erection of a northern capital, from which a maritime intercourse might be maintained with the other European powers. With the rapidity of action that usually followed his resolves, this measure was commenced. Artificers were collected from all parts; and abundance of working men were furnished by the events of war, from Sweden, Livonia, and Finland. The ground for houses was given to those who built them; and many of the nobility were induced, if not compelled, to erect mansions, by which employment was given to those who possessed nothing but their labour. Within two years from the commencement of the city, those parts of the city now called the Admiralty quarter and the Peter's Island quarter were covered with splendid dwellings, where, before, there had stood only two fishermen's huts. The trade was slow in reaching the new city. In the year 1714, it had been visited by sixteen foreign ships. In 1730 the number was 180; and since that time the increase has been gradual up to the present day, when they are more than 1500 annually. After the year 1714 the city was declared to be the seat of government, the emperor also making it his residence, upon which splendid buildings were erected for the various public offices. Since that period there has been an increase both of inhabitants and edifices; but the most rapid advance has been from the year 1816 to the year 1836.

Had Peter been in possession of Livonia at that time, it is probable he would have selected Riga for his northern capital, rather than the spot on which St Petersburg now stands, as it enjoys a climate in some degree more temperate, and has an easier access to its harbour, as well as a more secure and capacious bay without it. St Petersburg, in fact, has no harbour; but its sea-port is the city of Cronstadt, which is the chief station of the imperial navy and of the merchant-ships. It is built on the Kotlen Island, which is about six miles in length, and is composed almost entirely of sand, except a ridge of granite, which runs through the centre of it. Cronstadt city, on the south-eastern part of the island, has about 50,000 inhabitants. It is fortified both towards the land and towards the sea, and has two havens for ships of war and one for trading vessels. The principal men-of-war's port has sufficient space for thirty sail of the line, but not sufficient depth of water for such a number, and some are obliged to remain in the middle port. The merchant's haven is closed by a boom, and defended by a battery on each jetty-head. A canal, twenty-five feet in depth and fifty-two feet in width, begun by Peter the Great, and completed by the Empress Elizabeth in 1752, leads to the dry docks, which are 150 fathoms in length. When the docks are filled, as there is no flux and reflux of the tide, they can only be emptied by pumps worked by steam-engines; an operation which it requires eight or nine days to perform. It is about twenty miles from Cronstadt to St Petersburg by water. The channel is contracted by shoals in the narrowest part to about half a mile. In some parts the water is only from six to seven feet in depth, except when strong westerly winds raise it a foot more. The goods from and to the merchant-ships, as well as the warlike stores for the arsenal, are conveyed by lighters; and of late steam-tugs have been introduced, to facilitate the passages of these lighters. The whole banks are powerfully protected by batteries and by Cronstadt Castle. The city of St Petersburg was originally founded on portions of land either pure sand-banks or marshes, through which the river Neva, from the Lake of Ladoga, forces its way with a most tortuous course, forming islands in the way to its several mouths. These islands are now component parts of the city, being for the most part covered with buildings, connected by bridges over the branches of the stream that divide the city and the numerous canals, which in various directions intersect almost the whole surface. The most extensive part of the city, that in which the admiralty stands, is nearly a peninsula, enclosed in a bend of the stream called the Great Neva. The abundance of internal water communication is to St Petersburg, as to the other aquatic cities, Amsterdam, Rotterdam, Hamburg, and Venice, a great benefit to commercial operations, as the lighters can be loaded or discharged directly from or into the storehouses of the merchants.

The bridges across the streams and the canals, with the exception of one of iron over the Moika, are constructed of barges built on purpose, moored with cables and anchors at each end, and covered over with planks, to enable carriages to pass. At the commencement of winter, when the Neva begins to freeze, lumps of ice are first seen floating; and when these appear the bridges are immediately taken to pieces. During one or two days the pieces of ice drift with the stream, and the river is crossed in boats; but the increase of the ice is so rapid, that it is not unusual to see, within the space of two hours, the river covered with boats, and people walking on the ice. In the spring, the breaking up of the ice generally occurs suddenly, and it floats in large masses down the stream. When the river is clear, the circumstance is made known by the firing of cannon and by other public demonstrations, and is usually accompanied with joyous festivals. A traveller who visited this city in 1806 relates, that on the 8th of November the river was covered with floating ice. On the same day the bridges of boats, their anchors being drawn up, were swung round to the two opposite shores, and remained there till the thaw took place, on the 11th of May. In two days the river was completely thawed, although, just before, men, women, horses, and carriages, had been passing over it upon ice five feet in thickness, and a week before they had held a fair, and raced in sledges. The sudden breaking up of the frost is one of those physical evils from which St Petersburg is peculiarly liable to suffer, and has suffered at various periods, but most severely in the year 1824. When the water from the Lake of Ladoga is impeded by the masses of ice in the Neva, an inundation of a most extensive nature is occasioned, and visits the inhabitants of St Petersburg, especially those of the lower classes, with most terrible sufferings.

The means of maintaining intercourse by sea with the rest of the world having been noticed, it becomes natural to turn our attention to the foreign trade actually carried on at St Petersburg. Its position, in spite of the severity of the climate, and the long duration of the winter, is favourable for the transmission thither of the native products from the greater portion of the surface of that vast empire. Rivers of great length empty themselves into the lake of Ladoga, an inland sea more than one hundred miles in length and sixty in breadth. These rivers are at great distances from the metropolis, connected, by means of artificial canals, with other streams running in different directions. Thus, the products of the southern provinces may be exported either from the Baltic or the Black Sea ports, as the markets may be more beneficial, or the means of internal conveyance may be more or less costly. On the rivers and canals here alluded to, the heavy goods are conveyed by water while these continue open; whilst, on the other hand, during the long frosts, when the whole surface is buried in deep snow, they become, when once settled or beaten down, excellent roads, on which the heaviest commodities can be conveyed by sledges at a less cost than by water. In fact, the frozen roads, rivers, and canals, have an effect on Russian interchange of products similar to what may be experienced in this country when the numerous railroads now projected shall be carried into execution.

It is from these facilities of internal intercourse that a city so large as St Petersburg, in a district of little fertility, and in a climate which closes its port during nearly half the year, is not only abundantly and cheaply supplied with all the necessaries of life for its own consumption, but has become the emporium of the foreign commerce of the empire, as regards both its exports and its imports.

It appears by the returns from the Russian custom-house, that the commerce of St Petersburg, with its dependent port of Cronstadt, in the two years 1830 and 1831, employed rather more than double the number of vessels required for all the other commerce of the empire; but the amount of duty collected there was about four times as great as that at all the other ports.

As our limits do not allow of inserting the tables necessary to show the rate of increase of the foreign trade of St Petersburg, we must confine ourselves to the exhibition of it at the latest period for which accurate documents are accessible.

Statement of the Trade of St Petersburg for 1834.

Articles Imported.	Quantities.		Value.	
	Poods.[1]	lbs.	Roubles.	Copecks.
Gold and silver....	...		7,107,405	30
Cotton twist........	462,970	2	39,242,522	58
Raw cotton.........	104,431	24	3,147,978	68
Coffee................	98,592	37	4,755,487	62
Raw sugar..........	1,373,712	3	31,051,498	76
Spices................	18,872	2	650,620	80
Silk goods..........	2,190	16	5,780,682	50
Woollen ditto.......	9,933	14	6,040,239	35
Cotton ditto........	9,586	24	3,601,232	0
Linen ditto..........	679	15	584,452	75
Wine in casks......	96,021	0	5,441,931	0
Ditto in bottles....	446,262	0	2,584,859	15
Spirits................	8,130	0	994,939	0
Drugs.................	...		1,258,863	11
Sundries............	...		58,875,191	49
			171,117,904	9[2]

Exports of St Petersburg in 1834.

Description of Goods.	Quantity.	Value.
	Poods.	Roubles.
Hemp..............................	1,894,767	14,945,942
Flax................................	263,451	2,445,008
Potash.............................	367,771	2,267,657
Tallow.............................	3,721,238	43,843,095
Tallow candles................	19,138	238,708
Raw hides.......................	224,753	4,785,547
Dressed hides..................	42,610	1,786,291
Iron.................................	505,302	3,120,299
Copper............................	293,128	11,623,925
Bristles...........................	43,357	4,300,969
Cordage...........................	199,598	1,227,124
Linen (pieces)..................	187,312	7,427,050
Corn (chests)...................	1,117	3,969
Sundries..........................	...	21,434,225
		119,449,808

Or, in sterling money, L.4,777,992.

Although by these accounts the excess of imports much exceeds that of exports, yet, as the reverse is the case at the neighbouring port of Riga, the balance is nearly equalized in the whole trade of the Baltic.

The following is a summary of a report made by the Russian minister of finance, on the exports of St Petersburg during the year 1837. Copper, 6,078,060 lbs.; iron, 26,448,960 lbs.; raw hemp, 79,579,440 lbs.; spun hemp, 2,205,120 lbs.; cordage, 13,624,080 lbs.; oil of hempseed, 10,268,600 lbs.; bacon, 153,662,200 lbs.; tallow candles, 500,760 lbs.; soap, 60,799 lbs.; caviare, 76,080 lbs.; wool for mattresses, 1,211,360 lbs.; hogs' bristles, 1,945,680 lbs.; horse-hair, 572,720 lbs.; feathers, 896,200 lbs.; down, 51,480 lbs.; eider-down, 128,040 lbs.; aniseed, 75,160 lbs.; antimony, 341,040 lbs.; dressed skins, 14,374 pieces; undressed skins, 56,492 pieces; mattresses, 183,368; sail-cloth, 49,634 pieces; sack-cloth, 183,314 pieces; military cloth, 58,275 pieces; Flemish cloth, 68,172 pieces; cloth for towels, 7,540,394 ells; woollen cloth, called kalamaika, 1,582,024 ells; cotton cloth, called hracatscha, 13,491,260 ells; linseed, 3,632,212 bushels; rye and oats, 962,598 bushels; timber and planks, 2,786,104 pieces. This merchandize has been exported in 1248 vessels, the greater number of which belong to Russia, England, and the United States of America.

An Account of the Number and Tonnage of Vessels which entered the Port of Cronstadt in three years, ending with 1831, *distinguishing the Countrics to which they belonged.*

Countries to which belonging.	1829.		1830.		1831.	
	Ships.	Tonnage.	Ships.	Tonnage.	Ships.	Tonnage.
Russian.........	16	2,760	16	2,742	22	3,496
British...........	773	165,348	701	144,320	946	197,674
Swedish.........	78	6,632	79	6,346	64	6,172
Prussian.........	60	6,220	61	6,746	52	7,044
Danish...........	63	7,058	55	6,804	73	9,326
Dutch............	103	13,160	122	13,184	122	14,356
Hanseatic.......	132	17,330	132	17,446	128	20,460
German..........	31	2,358	25	1,858	28	2,552
French...........	129	18,520	129	18,964	63	9,124
Spanish..........	11	1,520	6	716	11	2,002
Portuguese.....	7	900	9	992	10	1,260
Italian...........	31	5,054	21	3,404	25	3,748
Austrian.........	3	580	2	318	2	284
Ionian Islands.	1	128	0	0	0	0
Indian...........	41	11,454	39	10,612	34	9,082
Egyptian........	1	166	0	0	0	0
African..........	1	204	3	484	2	346
Brazilian........	19	438	11	2,396	0	0
American.......	10	2,824	12	3,256	13	3,570
Canary Islands	0	0	0	0	4	490
	1,510	267,054	1,423	240,588	1,598	290,990

It thus appears, that of the trade of St Petersburg in the three years here exhibited, whilst the whole tonnage amounted to 798,632 tons, that of Great Britain alone was 507,342 tons, or somewhat more than five eighths of the whole.

In connection with trade, it may be proper to notice the singular and semi-barbarous regulations under which the mercantile community are placed. They are divided into three classes, which are called guilds. The merchants of the first guild have very extensive privileges. They may import or export any quantity or quality of goods permitted in the tariff, and sell or buy bills of exchange; in fact, they have the same privileges as the most favoured mercantile community in any part of Europe; and, in common with the nobility, they may have four horses to their carriage, and may possess country-seats and houses in town. Those of the second guild may transact all kinds of wholesale inland business, but they have no right to export or import on their own account, neither are they allowed to sell any bills of exchange, although they are not debarred the privilege of purchasing them. They can only use two horses in their carriages; and although they may possess houses in town, they must not be owners of country-seats. The third guild is composed of all descriptions of shopkeepers and retail-dealers, who are obliged to purchase their supply of stock from merchants of the two other guilds. All craftsmen belong to this class. There are instances in which craftsmen carrying on business on an extensive scale have been allowed to set up their carriage, and purchase property wherein to transact their business; but the mercantile members of the third guild are entirely excluded from this privilege, it being considered that they never lay in so large a stock as to require so extensive premises. They may only keep a horse and cart or sledge. Foreigners who wish to transact business may reside here as strangers, but they are obliged to take a license as merchants of the first guild, in which case they have the same privileges as the most favoured of that class, excepting only the right of holding real estates. There are some of the shopkeepers, and amongst them men of very large fortunes, who are not freemen, but pay a yearly tax to their masters for the liberty of residing out of his estates. The possession of their fortunes is very precarious, it being at the option of their lords to cancel the permission of absence.

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[1] The pood is a Russian weight of thirty-six pounds avoirdupois.

[2] Or L.6,634,748, the rouble being valued at the twenty-fifth part of a pound sterling.

As St Petersburg is the great conduit through which the supply of the wants of almost the whole of Russia, with its population of more than fifty millions of inhabitants, is transmitted, we must take notice of the internal means of collection and distribution which the city enjoys. It appears that in a series of years there arrive annually about 12,000 vessels from the interior, loaded with goods. These are denominated barges, galliots, or boats; besides which there are about 5000 floats or rafts of wood for fuel, for building ships, or for constructing houses. The value of the goods thus brought has been estimated at about 125,000,000 of roubles, or L.5,000,000 sterling. The number of this craft that is despatched with cargoes does not much exceed one tenth of those that arrive; but as they are of the best description, the value of the goods they convey back is calculated to amount to near L.1,000,000 sterling.

It may be seen by the former accounts of exports, that the whole annual amount nearly equals that which is here shown to arrive from the interior, and that these exports are chiefly composed of raw materials. It is obvious, then, that the manufactures which the city furnishes to foreign commerce must be of very inconsiderable amount. In fact, it will be seen, by the short notices given in the sequel, that they are chiefly calculated for home consumption, or to be presented to individuals, as marks of the emperor's esteem. The manufactories of china, and especially of glass, are the most distinguished. Of these there are six or eight large establishments in the city and within a few miles of it.

In the imperial glass manufactory mirrors are cast of larger dimensions than any which have issued from the fabrics of the same kind at St Ildefonso, Paris, or London. The largest was presented to Prince Potemkin, and measured sixteen feet two inches in height, and eight feet four inches in breadth. Another of the same dimensions was made for the Duke of Wellington; and some of less size have been presented to other distinguished personages at home and abroad. The cut glass made here is remarkable for elegant designs, and the peculiar purposes for which these are contrived. The crystal bed designed as a present to the shah of Persia may be mentioned as an instance.

The porcelain manufactory employs more than a thousand persons. The paintings on the china are chiefly executed by foundlings trained to the employment. The gilding is said to be superior to that executed at Sèvre or Dresden. The fabric is chiefly devoted to making objects of taste and luxury, and yields but little advantage in a commercial view.

The iron-founderies are upon a large scale; and there are, besides, under the patronage of the government, some establishments for making steam-engines, such as the various descriptions of machinery applicable to the spinning and weaving of cotton, linen, and silk goods, and the manufactory for making playing-cards, which gives employment to more than a thousand foundlings of both sexes. One of the most considerable establishments is about twenty miles from the city, and serves to supply every kind of store for the fleet, whether in the Baltic, the White Sea, or the Black Sea. Its management is praised by Captain Jones of the royal navy, who, speaking of it, says, "They must watch us closely, and have the best intelligence; for almost every nautical invention that is considered as an improvement in our service is made and to be seen at Kolpina."

The facilities afforded to commerce are in St Petersburg quite equal, as regards banks, to that of the other trading cities of Europe. The Commercial Bank has a capital of 30,000,000 roubles, or L.1,400,000; but it also takes in money on interest, and lends it at a trifle higher, on good security. The Loan Bank is of nearly the same power, and performs similar operations. Besides, there is the Lombard or Mont de Piété, an establishment for lending money on jewels, plate, or goods of any kind. It has a capital of 50,000,000 of roubles, or L.2,000,000 sterling, the interest arising from which is appropriated to the support of the great foundling hospitals of Moscow and St Petersburg, and to some other charitable institutions.

The following classification of the inhabitants of St Petersburg in September 1832, according to a consular return, seems properly to precede any view which can be taken of the edifices of that city. By this authority the progressive growth of the population is shown as ascertained at four different periods. In 1810 it amounted to 250,000, in 1820 to 350,000, in 1830 to 448,649, and in 1832, as stated below, to 479,993. The numbers given for 1810 and 1820 are deduced from calculation, but they cannot be far from the truth; those for the last two years were obtained by actual numerations. The increase is not supposed to have been at the same rapid rate between 1832 and 1837.

A Statement of the Population of St Petersburg, distinguishing the Classes and Sexes, in September 1832.

Classes.	Males.	Females.	Total.
Clergy	1,034	740	1,774
Nobles	24,342	18,426	42,768
Merchants	7,121	4,319	11,440
Burghers	25,914	14,789	40,703
Foreigners	9,160	5,502	14,662
Military	45,324	9,883	55,207
Artisans	7,020	4,065	11,085
Servants	68,480	34,457	102,937
Peasants	116,974	24,752	141,726
Various	33,877	23,814	57,691
	339,246	140,747	479,993

The great disproportion between males and females is a peculiarity in this city. Whilst in London the females exceed the males nearly in the proportion of seven to six, and in most of the other capitals the numbers of the sexes approach to equality, the above table shows that in St Petersburg the males exceed the females almost in the proportion of three to one. On looking to the increase before stated, it appears the more extraordinary that it should have taken place with so few females; and hence it may be concluded, that the drain on the general population of the empire to supply the mortality of this northern capital must be much greater than in the other European countries.

The view of St Petersburg first strikes a beholder with more surprise than is experienced on entering any other of the great cities. This is more impressive from the contrast of the wretched-looking country which is passed through on approaching it by land. The streets are wide, straight, and well paved for both foot-passengers and carriages; and some of them long, especially two, which run diagonally from the Admiralty to the extent of more than a mile. These streets on both sides are filled with public buildings of a bold style of architecture, many of them belonging to the several branches of the government, or to public institutions; numbers are also occupied by the nobles and other distinguished individuals, and thus on the whole give to St Petersburg some title to the appellation of "the northern city of palaces." It is, moreover, to a stranger, who is not aware of the peculiar structure of society here, not a little surprising to remark the total absence of those dark and wretched courts and lanes, the abodes of the lowest classes, which in other cities obtrude themselves on the notice of the traveller in the midst of grandeur and stateliness of exterior. The greater streets run parallel or nearly so to each other, and are intersected at right angles by others called lines, which have no names given to them, but a number to each. Every house is numbered; and, besides, the name of the occupier must be exhibited on the outside, and is most commonly painted on a board affixed to the wall. As the soil on which St Petersburg is founded may be said to be marshy, most of the houses are built on piles, as at Amsterdam, Rotterdam, and Venice, the ground not being sufficiently firm to afford a good foundation of stone without them; but no inconvenience is found to arise from this circumstance, either with regard to health or to comfort.

One of the most remarkable features of this great metropolis is undoubtedly the Neva, a river which, whether we consider its origin, its great rapidity, its depth, and the beautiful transparent-blue colour of its water, impresses the beholder with delight very different from what is experienced in looking at the Thames, the Seine, the Po, the Tiber, the Vistula, or the Elbe. It may best be compared with the Rhone as it rushes out of the Lake of Geneva. As before remarked, this stream is crossed by various temporary bridges, resting on pontoons, as are also some smaller streams that fall into it, and contribute to form the several islands upon which the city is built. The quays on the Neva form objects worthy of much admiration. Most of them are built of granite, and one of them, more than two miles in length, is raised upon piles ten feet above the common level of the water. Between the water and the buildings there is a carriage-way from thirty to forty feet in breadth; and at certain distances are placed handsome flights of stairs, for loading and for embarking, and for procuring water, with seats for the accommodation of passengers. The canals are in the summer season favourable for conveyance from one part of the city to another; and abundance of boats are provided, conveniently fitted up for passengers. In the winter, these canals, as well as the streams, being frozen, make very good roads for travelling on by means of sledges, which move with almost incredible celerity. Carriages of various kinds, both for winter and summer, are abundant in many parts of the city, at cheap rates; but they are represented as neither elegant nor easy to the traveller.

In a city like St Petersburg, the seat of the central government of a country containing more than 50,000,000 of people, and where the public offices are of a number and extent commensurate with such a population, it would occupy too large a space to describe each public edifice; but the peculiar magnificence which distinguishes many of them will not allow of their being passed over.

Before mentioning the palaces belonging to the emperor and the imperial family, the magnificent gate at the entrance to the city deserves to be noticed. It is built of granite, and consists of one bold arch of a noble but simple style of architecture, supporting an entablature, on which are raised vases of white marble. It was built to commemorate the victories obtained over the French on the return of the army which had achieved the capture of Paris. Through this arch is seen the winter palace of the imperial family. It is a grand and imposing structure, in a square form, three sides of which are unencumbered with any other building. The north front, looking on the Neva, is 720 feet in extent, one fourth of which line, at each extremity, projects twenty-four feet from the centre. It is composed of a basement story of the Ionic order, surmounted by a principal and a second story of the Corinthian order. The roof is surmounted by a light balustrade, adorned with vases and with statues. The Corinthian columns and pilasters, placed between the windows of the principal and the second story, twenty-six of which are single and six double, are about thirty-five feet in height. This is considered as the finest elevation of the building. Some critics have maintained that the style of the building is heavy; whilst others justify it, on the ground that so great a mass of front requires less of that airiness which is appropriate to buildings of smaller dimensions. As a whole, however, it is allowed to be more striking in its appearance than any of the royal palaces in Europe, excepting, perhaps, that at Madrid, which, though smaller, has a more imposing front. In dimensions it exceeds them all, and yields to none of them in internal decorations. The quay between the palace and the Neva is much wider than any other in the city. The south side of this palace looks into a square, and the view is terminated by the Admiralty, a structure to be noticed hereafter. The ordinary entrance is by a large door in the centre of the west front, in which are the apartments occupied by the reigning empress and the imperial children. The principal entrance is on the south side, in the centre, and is covered with a lofty portico, under which carriages drive and are sheltered from the weather. This leads to the grand or parade staircase, a flight of marble steps remarkable for the grandeur and magnificence of its architecture, and for the gilding, the paintings, and the various other decorations.

It would be an endless task to attempt a description of the different apartments of this palace, which occupies an area of 400,000 square feet. There are from ninety to a hundred apartments in the first story. The most striking of them is the great banqueting-hall, a noble apartment, 190 feet in length and 110 in height. It is incrusted with the finest marbles, with a row of columns at each end, and the sides are decorated with marble columns, enriched by gilding and by mirrors of the largest size. The other grand apartments in this edifice are St George's hall, 140 by 60 feet, the richest and most expensively furnished of any room on the Continent. It is used for the reception of ambassadors, and for holding the chapter of the military order of St George. The Salle Blanch, or Whitehall, is a similar room, equal in dimensions, but more chastely and less expensively decorated; and so is the military gallery, which is 180 feet in length. It is lighted from the top; and, besides circles representing wreaths of laurels descending from the ceiling, has numerous rich and splendid candelabras, for the purpose of illuminating the gallery. The walls are wholly covered with half-length portraits of military and naval men who have distinguished themselves. The greater part of these portraits are said to be admirable likenesses, and most of them were executed by an eminent English artist, particularly that of the Emperor Alexander, twice as large as life, on his white horse, which is placed in a recess, the light being so managed as to throw on the painting additional beauty and animation. Adjoining to this, called the Winter Palace, are two other edifices, called the Great and Little Hermitage. These parts are a continuation of the Winter Palace on its eastern side, connected by covered galleries upon arches which cross two streets. Beyond these there is a third building, containing the theatre, joined to them by means of another great arch over a canal which connects the river Moika with the Neva. These three buildings present a frontage towards the Neva of 776 feet, making, with the continuation of the Winter Palace, a line of imperial palaces of more than a third of an English mile in length.

The interior of these palaces is most gorgeously decorated, and contains apartments enriched with collections of the fine arts. The rooms of painting are filled with the works of the most celebrated artists, which are arranged conformably to the various schools, viz. the Flemish; the Italian of the several stages, in six apartments; the Rembrandt, with the most valued of that master; and the French school. In the same apartment may be seen a collection of the best pieces of the Dutch masters, Teniers, Gerard Dow, Vandevelt, Vandemeer, and others. Other apartments contain pictures of the Spanish artists, amongst which are some of the most valued pieces of Murillo, and also a great number of Raffaelle, and the collection from Houghton in Norfolk. Cabinets of mineralogical specimens are formed in these parts of the buildings, besides vases of the best porcelain, and a vast variety of engravings. It would be tiresome to enumerate the most striking objects contained in this repository of antiques, cameos, statues, bronzes, and other articles of *vertù* which adorn these hermitages, designed by the Empress Catherine as a retreat from the parade of a court and the bustle of public affairs. In the library collected by her in this spot there are 110,000 volumes of all languages, amongst which only 10,000 are in Russian. The theatre of the Hermitage is not large, and has no boxes; the seats for the audience rise like an amphitheatre; and in front there are several richly decorated arm-chairs for the members of the imperial family. The interior of this theatre is superbly decorated; whilst its exterior, as seen from the quay, is considered as one of the happiest efforts of architecture.

Few objects present more of novelty, and excite more of surprise, than the gardens attached to these buildings. The winter garden is a large quadrangular conservatory, planted with laurels and orange trees, in which linnets and canary birds are allowed to fly about at perfect liberty. The summer garden is in the form of a parallelogram, 392 feet in length, and entirely composed of artificial soil, raised forty-two feet above the surrounding ground. Here, suspended as it were in the air, the visitor, to his amazement, treads upon gravel walks, sees the green turf around him, and finds shrubs, and even trees, growing in luxuriance. The novelty of the whole scene, and the recollection where it is situated, not on the ground, but on or near the top of a palace, produces an overpowering effect, and gives the feeling excited by other parts of the Hermitage, and confirmed by this concluding scene, that the sight of it alone is worth a journey to St Petersburg.

The other palaces cannot be wholly passed over, though it may only be necessary here to notice them very shortly. The Marble Palace, once belonging to Orlof, but now to the crown, is remarkable for its richly gilded ornaments, and the number of its marble columns. The Taurida Palace, in which Potemkin gave his splendid entertainment to the empress, and which has devolved to the crown, is remarkable for the furniture of its splendid apartments, but especially for its theatre, in which the front parapet of the boxes is made of solid cut crystal, with a contrivance to admit lights behind them, so as at night to throw a dazzling splendour around the audience. The Palace of Nevskoi Prospekt, on the quay called Fontanka, is remarkable for its handsome exterior, as well as for the imperial cabinets appertaining to it, in which the private treasure of the emperor, his state robes, and his armoury, are kept.

The Imperial Mews is remarkable for the splendour of its architecture. The principal front and superb elevation face a spacious square, on the opposite side of which there is a range of buildings for the accommodation of those belonging to the establishment. The centre of the principal front is occupied by a church for the Mews, in a Grecian style of architecture, and on a scale commensurate with the imposing attitude of the entire edifice. This edifice is the work of Trombara, an Italian artist, and the exterior is in most excellent preservation, great care being taken to keep the whole of these stuccoed buildings in an unsoiled and delicate white tint.

The triumph of modern architecture in St Petersburg is eminently visible in the recently-erected palace, called, from the prince who occupies it, the Palace Michaeli. It has been constructed by an Italian architect named Rossi. It was begun in the year 1819, and completed in 1825, at an expense of seventeen millions of roubles, or L.680,000, including the furniture, which is almost wholly the work of native Russians. This magnificent structure presents a front 364 feet in length, and consists of a main body and two projecting wings. In its interior it combines every thing that decoration, rich and beautiful workmanship, and costly material, conducted by consummate skill and pure taste, can accomplish. It is especially remarkable for the suitableness of the plan, which was designed as well for comfort as for magnificent display; and it would be difficult to find in St Petersburg, or in any other capital, an instance of a residence, every subdivision of which is equally well calculated for its individual purpose, and yet neither interferes with nor injures the usefulness and effect of the rest, or of any part of the structure.

After the splendid palaces of the imperial family, the buildings in which the affairs of the several branches of the government of the vast country are conducted require to be noticed. The senate-house, though not in its exterior very remarkable, is so from its vast extent, the prodigious quantity of business carried on, and the corresponding number of official persons employed in it. It is a quadrangle, covering an area of about 14,000 square feet, or somewhat more than one third of an acre. In one of the halls, which serves as a conference-room, within a kind of temple made of solid silver, the original manuscripts of the code of laws given by the Empress Catherine are preserved, all of which are said to be in her own handwriting. The front of this building faces the statue of Peter the Great, and, from its situation, forms the north-west angle of the Square of Isaac. Close to the senate-house, and forming the opposite side of Isaac Square, is the western wing of the Admiralty, an edifice which, in its present state, may with truth be represented as without a parallel in any part of Europe. Its principal front upon the land side measures more than one third of an English mile in length, and its depth extends, to the edge of the water, six hundred and seventy-two feet, or one eighth of a mile. The centre of the principal façade is occupied by a large gate seventy-five feet in height, being a kind of triumphal arch, surmounted by a rich Doric entablature. The principal entrance is between two colossal groups placed upon granite pedestals, and bearing celestial and terrestrial globes of huge dimensions. Over it is a cupola, surmounted by a lantern, from which a spire rises to the height of eighty-four feet. This spire is covered with the finest ducat gold, and, from its great elevation, catching and reflecting the first and last rays of the sun, exhibits a most brilliant appearance, being visible from every quarter of the metropolis. On either side of this grand entrance the building projects two hundred and fifty feet, with a rusticated basement, surmounted by a running frieze, which contains naval trophies in bas-relief.

The interior plan of this vast building presents many portions of vast interest, which our limits compel us to pass over slightly, or omit noticing. Amongst the most extraordinary in the inner area of 62,300 square feet, are four slips for building men-of-war, in which several of from seventy-four to 110 guns have been constructed. This spot is surrounded by most capacious warehouses, in which are deposited every species of article necessary for the equipment of an extensive and powerful naval armament. Besides the apartment required for officers, and for the residence of the chief officers of the establishment, there are museums, with collections of whatever can be rendered subservient to the naval service, and such curiosities as have been collected in distant countries by Russian navigators. Arms of various kinds both for sea and land service, nautical instruments and models of machinery, models of ships and of boats, maps, charts, and plans of fortified ports, presses for printing, rolling copper-plates, and lithography, and a most copious library of professional books and manuscripts, are amongst the interesting exhibitions of this vast and magnificent building.

Near to the Admiralty there is another edifice of a similar nature, but inferior in extent and splendour of architecture, called the *Etat Major*, or the general staff of the army. In this building all the affairs of the military establishment centre; and the number of clerks, both civil and military, is prodigious. The grand saloon is a splendid apartment, with a cupola, from the centre of which is suspended a magnificent lustre, with thirty gas-burners, which, with four colossal candelabras of bronze, surmounted by the imperial eagle grasping the thunder-bolts, serve to illuminate the apartment. The library, the incombustible hall in which the documents and records of the army are preserved, and the model-rooms and museum, are striking objects in this building.

The castle of St Michael, in which the Emperor Paul was assassinated, and which has never since been occupied by any of the imperial family, is now converted into a military seminary for the education of officers of artillery and engineers. This is a vast building, once strongly fortified, and with an interior so ornamented, that Kotzebue, who saw it in its splendour, compares it with ancient descriptions of the gorgeous palace of Nineveh. The fortifications have, however, now disappeared, and the interior is filled with students in five classes, engaged in pursuits connected with the higher branches of the military art.

The two arsenals, and the foundery upon the banks of the Neva, present the appearance of a vast mass of building of considerable grandeur, and in the style of the Grecian architecture. Amongst every thing that can be useful in the art of war there are preserved some warlike remains of ancient times; amongst which are the rich arms of the Teutonic knights, removed from the arsenal of Riga to St Petersburg after the capture of that city.

The different departments of the executive civil government of the empire, called the Colleges, are appropriate buildings, and one or two of them fine specimens of architecture. The college of foreign affairs, with the residence of the chief, is an elegant structure, as is also that of the college of the interior. The colleges of war, of marine, of justice, and of commerce, have each handsome buildings, and attached to them beautiful residences for their several chiefs.

The post-office is a fine and large building, where not only the conveyance of letters is arranged, but the conveyance of money from one part of the empire to another; and it has the superintendence of the post-horses for the use of travellers at the several stations. The mint is in a fortress situated on a small island on the Neva. This citadel was the first of the erections of Peter the Great. It is furnished with five regular bastions, which range round the island; it is, however, no longer of any use for defence. The coining of money, as so much copper circulates, employs many hands, in spite of the admirable machinery supplied from England to diminish the labour; and the chief manager of the coining at present is a native of our island.

It has certainly been the object of the government of Russia under all its sovereigns to promote the civilization of its subjects by the diffusion of knowledge. Whether that object has been pursued in the right way; whether it has been too much confined to the few in immediate contact with the court, and not sufficiently communicated to the larger class; are questions which need not be discussed here. The means of spreading taste and information have been abundantly furnished to this capital at least. The Imperial Academy of Sciences was founded by Peter, who also established the rudiments of the extensive museums in the elegant building now occupied by that society. Some of the ablest mathematicians of Europe have been professors in it (for instance, Euler and the two Bernoullis), or members of it; and amongst the natives much progress has been made in astronomy, geography, and the other branches of science; whilst great advances have been making in each of the departments of natural history.

In the Academy, also, much has been done by individual members to propagate a knowledge of the national history and philology, of numismatics and Russian antiquities, of statistics and political economy, and in translating, from the French, German, English, and Italian languages, a great number of the most popular works into the Russian language. The astronomical observatory near the Academy, and connected with that institution, is sedulously at work, and publishes its observations. The several museums are all accessible to the public. They are, the zoological museum, the cabinet of mineralogy, the collection of dried plants, the Asiatic museum, the collection of ancient medals and coins, the three cabinets of Asiatic, Russian, and modern medals, and the cabinet of curiosities. To these may be added an extensive and well-selected library.

The Imperial Academy of Arts is one of those establishments to which the government has devoted considerable sums of money. The beauty and extent of the building, and the collections it contains, would entitle it to a fuller description than can be allotted to it in this place. The paintings, casts, and sculptures, are numerous, and many of the first merit. There are more than two hundred students receiving instruction in the different branches of the fine arts in this establishment; and a few at their own expense, amounting to thirty or forty pounds a year, which covers the expense of lodging and subsistence.

The Ecole des Mines attracts attention from its grandeur and its extent, as well as from the arrangement of the different rooms and galleries, and from the various collections illustrative of the mineralogy of all countries. The establishment, as well as the whole mining department, is under the minister of finance; and the students, about three hundred in number, are chiefly educated at the expense of the government, and are called cadets of the mining corps. The pupils, when properly qualified, are distributed amongst the vast mining districts of the empire, where their services are found to be of incalculable value.

But however expensive may have been the means applied to promote knowledge in the higher branches of science, there does not appear to be any appropriation, even in a small degree commensurate, devoted to the elementary kinds of instruction. The university of St Petersburg has but a limited operation, and, indeed, must be considered as imperfect. It has schools connected with it, which are bad specimens of the institutions from which they have been copied, called in France *Ecoles Normales*, or in Germany, Lyceums. It is said preparations have been made for improving the state of general education; and, in the mean time, there are abundance of private tutors, mostly Germans or Swiss, who give lessons by the hour to those youths who need instruction. Amongst the other institutions of St Petersburg connected with instruction, may be noticed those of a benevolent kind, such as a school for the deaf and dumb, schools for the children of soldiers, for the subalterns of the army, for the orphans of the military, and schools for the engineers, artillery, and the marine. Several schools of various descriptions, according to the rank of those who are taught, have been established by the females of the imperial family. Some of these are for the daughters of nobles, and others for burghers.

The only public library in the city is in a fine but scarcely finished building. The books that first formed it were obtained at Warsaw, on the partition of Poland. It is far from being a valuable collection, and is not much resorted to. One of the apartments contains a copy of every book printed in the Russian tongue since the art of typography has been introduced into that country. But the whole number of such works is not more than 15,000, scarcely more than the annual delivery from the printing-presses of Germany. See LIBRARIES.

The churches of the city are very numerous, and are for the most part appropriated to the religious services of the established or orthodox Greek communion, which comprehends about two thirds of the population. The most remarkable of the edifices appertaining to this class of religionists is called the Church of our Lady of Kazan. It is a large and splendid monument of architecture, although scarcely to be considered as of any of the regular orders. It abounds both in beauties and defects. It is in the form of the Greek cross, and the centre has a cupola not exactly in keeping with the columns in the façade; but, on the whole, it is a striking edifice. The interior is decorated with images of saints, and some pictures of no great merit. It has many military trophies in honour of the memory of those Russian heroes who have been interred within its walls, or of such of them as have been buried where they fell, and have been deemed worthy of a cenotaph. Another remarkable church is that of Isaac, built on the foundation of a more ancient temple, and only completed within the last few years. It is in a commanding situation, and of great magnitude, and in architecture somewhat resembles St Peter's at Rome. The form of the church is that of the Greek cross, being 334 feet in length, and 288 in width, including the lateral porticos. In the centre rises a dome, the exterior diameter of which, surrounded by an open peristyle of Ionic columns, measures 105 feet. The total elevation of the edifice, from the level of the square on which it stands, to the ball bearing the cross, is equal to 309 English feet. The interior is ornamented with 188 columns and pilasters of marble, of the Corinthian order. The capitals and the shafts are of bronze, richly gilt. The arched roof, decorated with various compartments, and embellished with every thing that painting, sculpture, and gilding can effect, render the whole not unworthy to rival many of the most distinguished churches of Italy.

Of the other churches, which are numerous, we can only notice one more. It is dedicated to St Paul, and has been the burial-place of the several emperors since that title was assumed. It stands within the citadel, and it has only a single cupola and tower, two hundred and six feet in height. Its lofty and slender spire, with gold glittering in the sun, is a well-known object to the traverser of the most distant parts of the metropolis, and by it he knows the centre of the city. The interior of this temple is remarkable for the simplicity of its decorations; but it is graced with a vast number of standards, batons, staffs, and keys of fortresses, taken from their enemies by the armies of Russia. The churches not named here are numerous, and most of them have domes, which, being of burnished copper, or richly gilded with gold, give an astonishing magnificence to the city as a whole, when viewed from any elevated spot. Besides the established churches, there are many belonging to professors of the Greek religion, not adhering to the orthodox faith. The Roman Catholics have a beautiful church of the Corinthian order, with a fine dome, surmounted with twenty-four elegant pillars. It was made the burial-place of the celebrated General Moreau, who died of the wounds he received near Dresden in the year 1813. A plain white tablet, edged with black marble, marks the last resting-place of the conqueror of Hohenlinden. There are two German churches for the Lutheran worship, which, though deemed excellent specimens of architecture, have few decorations, and nothing in the interior to attract much attention. An English church presents a noble front to the river. The interior is neat and simple, but the altar-piece is a fine painting of the descent from the cross. There is no gallery; and, although capacious, it is not sufficiently large to accommodate the whole of the English residents. The officiating minister has a good residence near the church; and both buildings are exempt from taxes, and from the domiciliary visits of the police.

The hospitals, especially those for the civil inhabitants, are numerous, and some of them are on a gigantic scale. In one of them, Smolnoi, more than 1400 patients are collected. At the Foundling Hospital more than 4000 children are received annually; and there are seldom less than 500 at the breast. Independently of the in-patients, the great hospitals relieve out-patients, the number of which exceeds 30,000 yearly. The empress has the superintendence of the hospitals and other charitable institutions, and is said to show great zeal in adopting any ameliorations in their arrangements that are suggested to her, but only after deliberate examination.

St Petersburg is abundantly supplied with objects for amusement, such as theatres for music, and for the representation of comic and tragic scenes in human life and manners. There are German and French houses in which plays are performed in those languages, and both a German and an Italian opera-house. The places of amusement are in some measure supported at the expense of the government; and thus, though the price of admission is low, the native Russians, excepting a very few who have travelled, seldom partake of them. They have, however, national music of a peculiar character, and several dances unknown in other countries, the enjoyment of which is highly gratifying. The ice-mountains and sledges are purely Russian amusements, and some peculiar athletic exercises, one of which is boxing, but with gloves on the hands, so as to draw no blood, and scarcely to inflict much pain.

All foreigners who have resided at St Petersburg agree that there are few great cities in which the police is conducted with more strictness than there. The public is very well secured. Robberies or murders are seldom heard of, and all thoughts of danger on these heads are wholly banished. At all hours of the night, and in the most unfrequented streets, the passenger passes without annoyance and without apprehension of danger. In each quarter of the city there is a station of the police, with a tower on which a watchman is constantly kept, to give an alarm in case of fire, by flags during day and by lamps at night; and fire-engines, with strong horses, are always ready, with some firemen, in case of need, and repair from every station to the spot where the accident occurs, which is indicated by well-known signals. There is an agent of police resident at each of the stations, who has an office, with several persons under him; he watches over the conduct and behaviour of the inhabitants of the district, preserves order and tranquillity in his quarter or section, and can decide in cases of petty quarrels, if the parties agree to such a course, as is sometimes done at the police-offices in London. There is a lock-up-house, and in some cases an hospital, attached to these police stations. Connected with the police is a corps called street-walkers, in small wooden boxes, in the various streets, at the door of which one always stands armed with a battle-axe. They consist chiefly of old but hale soldiers; and their duty is to prevent all obstructions by carriages, which are vastly numerous, to check the first symptoms of riot or disturbance, and to prevent begging in the street. In this last work they have been eminently successful, as no place in Europe is less distressed by the importunity of mendicants than this city. One of the duties of the street-walkers also is to go round with any new ukase of the emperor from house to house, to make the master of each acquainted with it, and to obtain an acknowledgment of his having read and taken cognizance of its import. It is thus that new laws are quietly promulgated throughout the capital.

One object in this city which has not yet been noticed is the colossal equestrian statue to the memory of Peter the Great. He is represented on a horse at full gallop up a rock, the top of which is a perpendicular precipice, on arriving at which the horse suddenly stops. The action is the moment of the sudden halt at perceiving the danger. It is admirably executed, and, being of prodigious size, excites the highest degree of admiration. (G.)

PETERSFIELD, a borough and market-town of the county of Hants, in the parish of Buriton, and hundred of Finchdean. It was erected into a borough by Queen Elizabeth, and is governed by a mayor and common council. It returned two members to parliament before 1832, but since that year it has elected but one. The market is held on Saturday. It is a place of little trade, except what it derives from being on the road to Portsmouth. The population amounted in 1801 to 1406, in 1811 to 1525, in 1821 to 1752, and in 1831 to 1803.

PETERS LE PORT, a market-town of England, in the island of Guernsey. It is situated on the south-eastern part of the island, and consists of one long, narrow street. It is defended by two ports, one of which, called Castle Cornet, stands on a rock, separated by an arm of the sea from the land, and which commands both the town and the harbour. A pier of vast stones affords protection to the harbour, where there is good anchorage, and whence ships may depart in all states of the weather; and it also forms a pleasant and extended walk. There is some trade with Newfoundland; and formerly there was much smuggling carried on, but that has been stopped by the introduction of a custom-house. The population has much increased of late years, and in 1831 amounted to 5966 males and 7924 females.

PETERSWALDAU, a city of the Prussian government of Reichenbach, in Silesia. It is finely situated, and has a large establishment of the United Brethren. It belongs to the family of Stolberg Wernigerode, and contains 510 houses, with 3080 inhabitants, who carry on extensive cloth manufactories.

PETERWARDEIN, a city of the Hungarian province of the Sclavonic military frontier. It is the capital of the limits of that regiment or circle, extending over 1244 square miles, comprehending four cities and towns, and sixty-one villages, with 91,618 inhabitants. The city is situated on the river Danube, is strongly fortified, and is the head-quarters of the military staff of the district. It contains, including its suburb Bucovetz, 680 houses and 4280 inhabitants. Long. 19. 47. 11. E. Lat. 45. 15. 30. N.

PETHERTON, NORTH, a town of the county of Somerset, in the hundred of the same name, 137 miles from London and three from Bridgewater. It consists of one long street, tolerably built; but the parish is very extensive, comprehending seventeen villages. The population amounted in 1801 to 2346, in 1811 to 2615, in 1821 to 3091, and in 1831 to 3566.

PETHERTON, *South*, a market-town of the county of Somerset, in the hundred of the same name, 137 miles from London. It is situated on the river Parret, which is navigable for barges nearly to the town. There is a small market on Thursday; and there are manufactories of linen. The population amounted in 1801 to 1674, in 1811 to 1867, in 1821 to 2090, and in 1831 to 2294.

PETIT, JOHN, a doctor of the Sorbonne, who very early gained to himself a name by his knowledge, and the eloquent orations which he pronounced before the university of Paris. He was employed in the famous embassy which was sent from France to Rome for the purpose of healing the schism in 1407; but he soon forfeited all the honour which he had acquired. John Sans Peur, duke of Burgundy, having treacherously contrived to assassinate Louis of France, duke of Orleans, only brother to Charles VI., John Petit, entirely devoted to the views of the murderer, maintained in a public disputation, at Paris, on the 8th of March 1408, that the murder was lawful. He had the effrontery to assert, that "it is allowed to employ fraud, treason, and every other method, however base, in order to get rid of a tyrant; and that no faith ought to be kept with him." And he had even the audacity to add, that "the man who should commit such an action, not only deserved to be exempted from punishment, but to receive a reward." This sanguinary doctrine was loudly exclaimed against; but the Duke of Burgundy's powerful influence sheltered Petit for some time. Some eminent writers of that period, however, with Gerson at their head, denounced the doctrine to John de Montaigu, bishop of Paris, who condemned it as heretical, on the 23d of November 1414. It was likewise condemned by the council of Constance the year following, at the instigation of Gerson; but no notice was taken either of Petit's name or of his writings. In fine, the king, on the 16th of September 1416, ordered the parliament of Paris to pronounce a severe decree against this dangerous performance; and it was also censured by the university. But the Duke of Burgundy, in 1418, had interest enough to compel the grand vicars of the bishop of Paris, who then lay sick at St Omer, to retract the sentence which that prelate had passed in 1414. Petit had died three years before this, or in 1411, at Hesdin; and his apology in favour of the Duke of Burgundy, with all the particulars of that infamous transaction, may be seen in the fifth volume of the last edition of Gerson's works. Father Pinchinat, of the order of St Francis, and author of the Dictionary of Heresies, has endeavoured to vindicate his order from a charge brought by some writers, who have called Petit a Cordelier or Franciscan friar. "He proves very clearly," says the Abbé Prevot, "that he was a secular priest;" and adds, that "upon the same evidence, Father Mercier, a Cordelier, had a warm dispute in 1717 with M. Dupin, who had given this title to Petit in his Collection of Censures. He represented to him," says he, "before a meeting of the faculty, the falsity of such a claim, and the injury which he offered to the order of St Francis. Dupin, convinced of his error, candidly owned that he was led into it by following some infidel writers; and promised to retract it in the new edition of the Censures, which was published in 1720. M. Fleury, who had committed the same mistake, promised also to make amends for it by a solemn recantation; but dying before he had an opportunity of doing that piece of justice to the Cordeliers, the continuator of his Ecclesiastical History, who had not such opportunities of information, fell into the same fault." (*Pour et Contre*, tom. x. p. 23.) If we follow L'Avocat's Dictionary, it would appear that no fault was committed; for it gives a list of the pensioners of the dukes of Burgundy, in order to prove that John Petit was a Cordelier. Indeed it is highly probable, that if Dupin, Fleury, and Father Fabré, did not alter their opinion, it was owing to a firm persuasion that they had committed no error.

PETITIO PRINCIPII, in *Logic*, is the assuming a thing as true, and drawing conclusions from it on this assumption, when it is either really false, or at least requires to be proved before any inference can be drawn from it.

PETIVER, James, a celebrated English botanist, contemporary with Plukenet. Of the precise time of his birth no notice has been preserved. He was by profession an apothecary, having served an apprenticeship under Mr Feltham, apothecary to St Bartholomew's Hospital. He settled in Aldersgate Street, where he commenced business on his own account, which he continued during the whole of his life. His business was extensive, and he afterwards became apothecary to the Charter-house. Excepting Sir Hans Sloane and Mr Courten, he was the only person after the Tradescants who made any important collections in natural history, previously to those of the present day. He employed the captains and surgeons of different ships to bring him home specimens; and by means of printed directions he enabled them to select proper objects. In this manner his collection soon became so valuable, that, some time previously to his decease, he was offered L.4000 for it by Sir Hans Sloane, by whom it was purchased some time after Petiver's death. Both at home and abroad his fame was extended by his valuable museum. He was chosen a fellow of the Royal Society; and having become acquainted with Ray, he assisted him in arranging the second volume of his History of Plants. He died on the 20th of April 1718; and his funeral was honoured by the attendance of Sir Hans Sloane, and other eminent men, as pall-bearers.

He published several works on different subjects of natural history, particularly, 1. Musci Petiveriani Centuriæ decem, 1692–1703, 8vo; 2. Gazophylacii Naturæ et Artis, Decades decem, 1702, folio, with a hundred plates; 3. A Catalogue of Mr Ray's English Herbal, illustrated with figures, 1713, and continued in 1715, folio; 4. Many small publications, which may be found enumerated in Dr Pultney's book; 5. Many papers in the Philosophical Transactions, and a valuable article in the third volume of Ray's work, entitled Plantæ Rariores Chinenses, Madras-patanæ et Africanæ, a Jacobo Petivero ad opus consummandum collatæ. Many of his small tracts having become scarce, his works were collected and published, exclusively of his papers in the Transactions, 1764, in two vols. folio.

PETLAD, a town of Hindustan, in the province of Gujerat, and district of Broach. It is sixteen miles north-east from Cambay. The inhabitants are here subjected to the servitude of acting as guides to travellers, from which only a certain caste, the Dhers, are exempted. Long. 73. E. Lat. 22. 27. N.

PETLAHWAD, a town of Hindustan, belonging to the Mahrattas, in the province of Malwah. It is seventy miles west by north from Oojain. Long. 74. 50. E. Lat. 23. 22. N.

PETRARCH, Francis, one of the greatest poets and most celebrated men of whom Italy can boast, was born at Arezzo on the 20th of July 1304. He saw the light amidst the rage of contending factions. His father, the friend of Dante, and, like him, of the Ghibelin party, had been banished from Florence, where he filled a respectable situation confided to him by the republic; and having taken refuge in Pisa, he committed the primary tuition of his son, then in his seventh year, to an old grammarian of that city named Convennole da Prato. Two years afterwards, when the death of the Emperor Henry VII. had destroyed the hopes of the Ghibelins, the father of Petrarch removed his family to Avignon, whither Clement V. had transferred the pontifical court, and his son resumed his studies at Carpentras, under his former master. It was then that the youthful pupil of Convennole visited for the first time the fountain of Vaucluse; and the rural beauties of this celebrated spot left an indelible impression upon his mind. In that age, the study of law was almost the only pursuit that led to fortune. Petrarch accordingly passed four years at the university of Montpellier, where, instead of immersing himself in the hazy erudition of the schools, he devoted his days and his nights to Cicero and to Virgil. At the same time he made himself familiar with the compositions of the troubadours, and, if we may credit Gariel, in his *Idea of Montpellier*, retouched the romance of *Pierre de Provence et la belle Maguelone*, written in 1178 by the canon Bernard de Triviés. But whilst engaged in these seducing pursuits, he was disturbed by the arrival of his father, who, greatly incensed at what he conceived to be a gross misapplication of time, consigned to the flames the little library of his son, and was with difficulty induced to restore to him Cicero and Virgil, after they had been half consumed. Being now sent to the university of Bologna, to receive the instructions of John d'Andrea, the most learned canonist of that age, Petrarch soon formed a connection there with Cino de Pistoia, a Florentine, like himself, whom Bartolo cites as his master in the science of law, and who deserved to become that of Petrarch and Boccacio in poetry. If the young legist did not long retain the lessons of the jurisconsult, he at least remembered those of the poet; and at a later period he did not disdain to consecrate to the memory of Laura several verses borrowed from the bard of Selvagia. At the age of twenty-two he lost his father, and being ruined by faithless tutors, he returned to Avignon, where he took up his residence, appeared with distinction in the most brilliant society, and found himself at liberty to apply to his favourite pursuits. The mathematics, which were then in their infancy, history and antiquities, philosophy with its innumerable systems, especially those which related to the science of ethics, occupied, each in its turn, a mind thirsting for knowledge. The first poetical attempts of Petrarch, like those of Dante, were made in the Latin language; but, happily, his muse soon ventured to confide her inspirations to the vulgar tongue, the only one, besides, which the women understood.

About this time, he renewed his acquaintance with one of his school companions, James Colonna, the youngest son of Stephen Colonna, the head of the illustrious family of that name. By the elevation of his mind, and his passion for letters, this young Roman was every way worthy to become the friend of Petrarch, and he continued to be so until the period of his death. Cardinal John Colonna, the eldest brother of James, desired also to share the friendship of Petrarch; and, in the society of these eminent individuals, the poet became known to the most illustrious strangers who visited the pontifical city; whilst the noble frankness of his manner, his mild yet sprightly physiognomy, the graces of his mind, and his unaffected anxiety to please, secured him a remarkable ascendency in this select circle. Colonna, the father, took a particular pleasure in recounting to him the events of his life, as well as in developing his projects; and it was in these conversations that Petrarch imbibed a new love of Italy, and a stronger aversion for every thing calculated to prolong its misfortunes or to obscure its glory. When James Colonna was called to the bishopric of Lombez, his friend accompanied him to his diocese, and in their way they stopped at Toulouse, where, a few years before (in 1324), Arnauld Vidal had been honoured with the poetical eglantine. The seven Maintainers of the gay Science were then beginning to diffuse a taste for the vulgar poetry, and to bring into notice those little effusions of song unknown to the ancients, and some of which have still remained peculiar to the literature of the troubadours. A submissive and unfortunate lover, Petrarch, like them, sought to console himself by singing at once the charms and the cruelty of his beloved. On the 6th of April 1327, on holy Monday, at six o'clock in the morning, he had seen, in a church of Avignon, the daughter of Audibert de Novis; and the passion he conceived for this lady occupied the remainder of his life, over which it diffused an air of poetry and romance. Laura was united to Hugues de Sade, a young patrician, and a native of Avignon; but, faithful to her duties as a wife and a mother, she forbade Petrarch to indulge the slightest hope. Incessantly haunted with this beautiful vision, the poet visited in succession the south of France, Paris, and the Low Countries; the forest of the Ardennes re-echoed in turn his verses and his lamentations; he traversed Burgundy, the Lyonnais, Dauphiné, and, after an exile of eight months, returned to bury himself in the delightful solitude of Vaucluse.

Pope John XXII. was then meditating a new crusade, and, to further his object, he led the Romans to hope that he would re-establish the chair of St Peter in Italy. This double project excited the imagination of Petrarch, and inspired his beautiful ode to the Bishop of Lombez, *O aspettata in ciel*, &c. The following year, 1335, we find him expressing, in beautiful Latin verses addressed to Benedict XII. his earnest desire to see the Holy See re-established in the eternal city; and to this patriotic aspiration the pope replied by appointing him canon of Lombez, with the hopes of a prebend. The same year was marked by an event unique in the life of Petrarch. A recent and close connection attached him to the interests of Azon de Corregio, one of the principal lords of Italy, who was then prosecuted before the papal courts at the instance of the family of the Rossi. In the hope of serving his friend, the poet resolved to plead his cause at the bar; and this he did with so eminent success, that it proved to both a day of triumph. Since he had first beheld Laura, he sought occupation everywhere, without being able to fix himself anywhere. A vague disquietude of mind led him to visit Rome, where, however, the friendship of the Colonnas could not detain him; and he returned to Avignon, from which, although he had no desire to establish himself in that city, he could not for any length of time stay away. Finding himself in this unsettled state of mind, he now shut himself up in his retreat at Vaucluse, without friends and without domestics, as if solitude could have extinguished a passion which increased in spite of all his efforts to subdue it. The country-house of the Bishop of Cavaillon adjoined that which he occupied. This prelate was Philip de Cabassole, whom the poet himself calls a little bishop and a great man. Petrarch could not refuse his consolations, and soon reckoned the good bishop amongst his friends.

About this time the lover of Laura seems to have been occupied with a great literary conception. He had commenced writing in Latin the history of Rome from the foundation of the city to the reign of Titus. But in collecting materials for this work, he was much struck with the grandeur of the events which had marked the termination of the second Punic war; and suddenly conceived the design of giving to his age a regular epic, of which Scipio should be the hero. His plan was hastily traced; some portions of the projected poem were written under the first access of inspiration; and, before the end of the year, the poet was in a condition to submit to his friends the greater part of his work, which they received with the most flattering encomiums, and, having exhausted the language of eulogy, styled the author *sublime* and *divine*. But a more grateful distinction awaited him. His sonnets and his *Canzoni* had filled France and Italy with the name of Laura and that of her lover; in fact, these pieces were universally read and admired. Of the impression produced by his poetical genius he had soon the most convincing evidence. On the 23d of August 1340, he received at Vaucluse two letters, one from the Roman senate, which invited him to accept the poetical laurel, and be crowned in the capitol, and the other from the chancellor of the University of Paris, which offered him the same triumph. It is a mistake, however, to give the credit of this proceeding to the learned corporation here mentioned. The most careful researches made in the registers have not detected a single trace of the deliberation which must necessarily have preceded the transmission of such a letter as that written by the chancellor; and every thing inclines us to believe that Robert de Barde, who then held that office, a Florentine, and the personal friend of Petrarch, had written him without consulting his colleagues, trusting to inspire them with his own admiration, whenever the poet should appear in Paris. The choice of Petrarch, however, was already made. He had long coveted the poetic laurel, and even made known his wishes to Robert of Anjou, king of Naples, whose influence had stimulated the admiration, and hastened the decision, of the Roman senators. This prince cultivated letters with enthusiasm, and protected them in a manner worthy of a king. Wishing to appear indebted to him for the crown which had been offered to him, Petrarch embarked for Naples, carrying with him his epic poem, which he had entitled *Africa*. The king and the poet had repeated conferences upon the subjects of poetry and history; but not thinking these sufficient, the latter demanded a more rigorous trial of his qualifications and acquirements, and offered to reply, during three days, to all the questions that might be proposed to him upon history, literature, and philosophy. In this public examination he acquitted himself to the admiration of all. Robert solemnly declared him worthy of the promised triumph; and at his audience of leave, the king, divesting himself of his robe, put it on Petrarch, at the same time requesting him to wear it on the day when he was to receive the laurel crown.

He then repaired to Rome, and, on Easter-day (the 8th of April 1341), ascended the capitol, in the midst of the principal citizens, preceded by twelve youths selected from the most illustrious families, who declaimed his verses. After a short harangue he received the crown from the hands of the senator Orso, count de l'Anguillara, and then recited a sonnet upon the heroes of ancient Rome, whose place he then appeared to occupy. Descending from the capitol, he was conducted, by the same cortège, amidst the acclamations of a crowd eager to witness so novel a spectacle, to the church of St Peter, where he deposited on the altar the laurel which encircled his brow; after which he set out for Avignon by land, as if to enjoy more leisurely his renown. He carried with him the title of almoner to the king of Naples, and letters-patent giving him, as well by the authority of King Robert as by that of the senate and people of Rome, full and free permission to read, vindicate, and explain the ancient books, to make new ones, compose poems, and on every occasion to wear the crown of laurel, ivy, or myrtle, at his pleasure.

Azon de Corregio having just usurped the sovereignty of Parma, on the pretext of freeing it from thraldom, urgently pressed Petrarch to spend some time with him; and, captivated by the attentions paid to him, the poet soon accepted the situation of archdeacon of the church of Parma, caused a house to be built there, and then employed himself in completing his poem of *Africa*. Glory had now begun to console him for his labour and anxiety, when envy, awakened by unexampled success, attempted to disturb his repose; and at the same time the hand of death had stricken the Bishop of Lombez, his best friend and warmest admirer. The accession of Clement VI. to the triple crown, in 1342, revived in the mind of Petrarch hopes which had already been twice disappointed. At the request of the Romans, he accompanied to Avignon the deputation they had sent for the purpose of soliciting the new pope to fulfil the promises made by John XXII., and, in this matter, he acted as the organ of the deputation. The pontiff received him with marked distinction, appointed him prior of Migliorino, in the diocese of Parma, and treated him with the greatest familiarity, but made no answer to the petition of the deputation, beseeching him to remove to Italy. At the same time, however, his holiness, anxious to testify the confidence he reposed in Petrarch, intrusted him with a delicate mission, namely, that of obtaining from the regency of Naples a recognition of the rights of the Holy See, during the minority of Jane, granddaughter of King Robert. The young queen conversed several times with Petrarch, who, besides, received public testimony of the esteem she entertained for letters; but the candour of the poetical negotiator rendered him the most unfit person in the world to control the selfish policy of the councillors by whom that princess was governed. He fled with horror from a barbarous and corrupt court, which sought relaxation from its debaucheries, in the depraving spectacle of gladiatorial combats. He crossed the Apennines, made no stay at Parma, and, eager to escape from Italy, then a prey to all the fury of contending factions, he returned to his beloved retreat at Vaucluse, where he remained several months. But a circumstance occurred which soon recalled him to Italy. Rienzi, having made himself master of Rome, cited kings to appear before him, and loudly proclaimed that his fellow-citizens were about to resume, in the fourteenth century, their ancient dominion over the world. All the illusions of Petrarch immediately brightened into realities. An ardent defender of the tribune even in the midst of the pontifical court, he now felicitated the popular leader on his success, exhorted him to persevere, and, impatient to counsel him on the spot, set out immediately for Italy. The news of the massacre of the Colonnas reached him at Genoa, and struck him with consternation; but still he felt disposed to pardon Rienzi, provided Rome had become republican. The sway of the tribune, however, was short-lived, and with his fall disappeared that wild phantom of liberty which had deceived Petrarch.

Scarcely a year had elapsed when the poet had to bewail a loss still more painful. Laura was no more. The pestilence of 1348, which Boccacio has described with such terrible truth, and which desolated all Europe, had carried her off on the 6th of April that year, on the same day, in the same month, and at the same hour, in which her lover had seen her for the first time. The last half of the *Canzoniere* is an immortal monument of the long regret of Petrarch. But although his verses had not made us aware of the sincerity of his grief for his mistress, the touching note which he inscribed upon his copy of Virgil would still attest the profane homage which he paid to her memory.[1] Yielding to the repeated instances of Luigi Conrado, lord of Mantua, Petrarch now repaired to his princely residence, in the hope of finding consolation in the native country of the most sensitive and affecting of all poets; and it was during his stay there that he addressed to the Emperor Charles IV. an eloquent letter, in which he exhorted him to restore peace to Italy. The publication of the jubilee in 1350 drew almost all Christian Europe to Rome. Petrarch, participating in this pious impulse, set out for Rome, and in passing through Florence, visited Boccacio, one of those whom he had particularly noticed at the court of Naples, and who now became his friend. At Rome he found the jubilee commenced, and this grand and consoling solemnity made a deep impression on his mind. His habits became more grave, his manners more austere; and from this time his thoughts assumed a character of severity, the impress of which is visible in his later compositions. At the same time he everywhere received honours which had never before been bestowed on any private individual. The principal citizens of Arezzo conducted him with pride to the house where he was born, assuring him that nothing had been changed in it; and, in fact, the town had obliged the proprietors, into whose hands this house had passed, to pay the most religious respect to the place consecrated by his birth.

The friendship of the Carraras having induced Petrarch to visit Padua, he had scarcely arrived when Boccacio came to announce to him, in the name of the senate of Florence, that he had been re-established in his rights as a citizen, as well as in the patrimony of his family, and also to offer him the directorship of the university recently founded in the first city of Tuscany. This honourable appointment, however, had no attraction for Petrarch. His books awaited him in his transalpine Parnassus, as he called Vaucluse; and his cisalpine Parnassus was his house at Parma. He accordingly declined accepting the proffered appointment, and hastened to bury himself in his favourite retreat. At this time Rome, filled with robberies and assassinations, occupied all the pontifical solicitude, with a view to repress these disorders; and Clement VI. invoked the counsels of Petrarch respecting the measures most proper to be adopted. Petrarch, however, replied like a poet rather than a counsellor. He spoke of the ancient rights of the Roman people, of excluding strangers from public offices, of restoring to the senate its dignity, and declared that he saw no safety except in the establishment of the republic upon the principles of equality and justice. About the same time, Rienzi, having fallen into the hands of the emperor, was delivered up to the pope, and brought before a judicial commission, against the legality of which he vehemently protested. It is said that Petrarch wrote to the Roman people, warmly exhorting them to interpose in favour of his old friend; and, in fact, this exhortation is found in his works. But there is nothing to show that it was sent according to its address; on the contrary, almost every circumstance leads us to believe that his imagination alone had prompted him to write this letter, rather to console than to save Rienzi. Nevertheless, from a superstition indicative at once of the ignorance and the knowledge of a semi-barbarous age, those judges, so impatient to punish a factious chief whom they believed unworthy of the ordinary benefit of the law, hesitated as soon as they learned that he was a poet, and feared to condemn a man belonging to an order which Cicero had pronounced "sacred." But the peril of the modern Gracchus was not the only vexation which Petrarch experienced. The physicians by whom the pope was surrounded, and whose ridiculous ignorance he had denounced to the holy father, combined against him. To suppose himself wounded by arrows which fell short of their mark, was no doubt an error on the part of the poet, and, under its influence, he humbled himself so far as to borrow the arms of his adversaries, in order to repel their attacks.

On his return to Vaucluse, that tranquil retreat inspired him with an answer more worthy of himself. This was his Epistle to Posterity, in which he gives an account of the principal events of his life, until his departure from Italy, about the middle of the year 1351.[2] Some months afterwards, Innocent VI. was called to the government of the church; a man of an irreproachable life, but of little knowledge, and the only pontiff from whom Petrarch did not receive some mark of favour. The poet, after having twice, under Clement IV. refused the office of apostolical secretary, was now suspected of magic by his successor, and he took no pains to dispel the prejudices of the new pontiff. His regret for Italy was only increased; and he repassed the Alps, uncertain where to fix his abode, although prepared to adopt as his country any place where he might live in tranquillity and independence. He had long wished to visit Milan, and, on this occasion, he proceeded no farther. Charmed with the reception he met with from a man of power, who knew well how to exhibit himself to the poet in an amiable light, and admitted to the counsels of John Visconti, Petrarch accepted a mission having for its object to bring about a reconciliation between the republic of Genoa, which had just given itself up to Visconti, and that of Venice, elated by recent and apparently decisive successes. Three years before, Petrarch had endeavoured to prevent a war which presaged long and bloody divisions in Italy. Connected with the Doge Andrea Dandolo, one of the greatest men of this age, in politics, in war, and in letters, the poet appealed to the patriotism of his friend, and the latter replied by praising the eloquence of Petrarch, but without deferring to his counsels. Hence this new attempt proved not more fortunate than the previous one; but events soon showed on which side lay the want of foresight. Venice was reduced to the necessity of purchasing peace; Dandolo died of grief, and Visconti survived him little more than a month. Nevertheless, after a silence of three years, the emperor replied to the letter in which Petrarch had called upon him to restore peace to his country, an appeal which he had several times renewed. But the avarice of Charles IV. furnished a more powerful motive to appear in Lombardy than the patriotic addresses of Petrarch. By his orders, the poet proceeded to meet him at Mantua, full of confidence in his wisdom, and hoping that, as the friend of the Holy See, he would for ever banish from Italy the names of Guelf and Ghibelin, which had caused the effusion of so much blood, and fomented such fierce animosities. But in this monarch he discovered only a weak and avaricious prince, who mistook treachery for talent, and exhibited the strange spectacle of an emperor of Germany in the pay of the Venetians. The poet presented him with some rare and valuable medals of Augustus, of Trajan, and the Antonines. "These," said he, "are the great men whose place you occupy, and who ought to be your models." During eight days which he spent in familiar intercourse with the emperor, Petrarch discovered the mean, narrow, and grovelling character of his mind, and refused to enter Rome in his train, or to be a witness of his coronation. He then attached himself more than ever to the nephews of John Visconti, whom the emperor had loudly menaced, with the view of enhancing the price to be afterwards exacted for confirming them in the usurpations of their uncle. At this period, the public hatred had accused them of fratricide. Petrarch, afflicted with a rumour which he could not believe, repaired to Pavia, where he was employed by Galeas, a friend of letters, to dissuade Charles IV. from undertaking a new expedition beyond the Alps. This embassy proved more successful than the former, apparently because the proceedings of the malcontents in Germany had produced a change in the versatile policy of the emperor. On his return to Milan, the ambassador received from him the diploma of Count Palatine, in a gold box of considerable value. Petrarch accepted this new honour, but returned the box to the chancellor of the empire.

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[1] The authenticity of this note is still disputed by those who wish to overturn the whole history of Laura. Mr Whyte, a learned Englishman, who discovered at Florence an inedited life of Petrarch, written soon after his death, by Luigi Peruzzi, who had known him, also rejects the evidence of this note. But it is written in a tone which ought to silence incredulity, because feigned emotions never bear the stamp of nature and reality. The Virgil of Petrarch has long been in the royal collection at Paris.

[2] Ginguené (*Histoire Littéraire d'Italie*, tom. ii. p. 582) shows, contrary to the opinion of Badelli, that the Epistle to Posterity was written in 1352, and not in 1372.

Fatigued with the agitation of courts, the poet now fixed upon a new retreat on the banks of the river Adda, in a pretty country-house, which he called Linterno, in honour of his hero Scipio. Literary projects and researches, religious exercises, and frequent visits to the charterhouse of Milan, now occupied his leisure. All the great lords of Italy had disputed with pontiffs and kings the honour of his presence and conversation. But a goldsmith of Bergamo, named Capra, solicited and obtained a sort of preference. At the approach of Petrarch all Bergamo went out to meet him, whilst Capra received him with a magnificence almost royal, and proved by his enthusiasm, not less than by the number and quality of his books, that he was worthy of his guest. In 1360 a new diplomatic mission led Petrarch to France, whither he went to compliment King John on the recovery of his liberty; and this prince, who had formerly made vain attempts to prevent his return to Italy, now renewed his efforts to retain him. But the envoy of Galeas returned to Milan, without suffering himself to be moved either by the presents of the monarch or by the entreaties of the dauphin; and those of the emperor, backed by the transmission of a gold cup of curious workmanship, found him equally inflexible. But never had a residence in Italy presented fewer attractions. The foreign companies who infested that land of discord, forced him to seek an asylum at Padua, whence he was soon afterwards expelled by the pestilence. He proceeded to Venice, accompanied with his books, which he always carried along with him, and, on his arrival, he presented his library to that hospitable republic, by a writing dated in 1362, on condition that so rare a collection should neither be divided nor sold. By a decree of the senate, a palace was assigned for the reception of Petrarch and his books; and it is, doubtless, this circumstance which has made him be regarded as the original founder of the celebrated library of St Mark.[1] The Abbé de Sade is therefore mistaken in supposing that all these manuscripts had perished. Tomasini, who made a search for them in the year 1635, discovered them in a small dark chamber, situated near the four bronze horses; and there they remained until the year 1739, when permission was at length given to the public to consult them.[2]

This residence at Venice, indeed, is doubly memorable in the life of Petrarch. It was here that, when driven by the plague from Florence, Boccacio came to share his asylum, and presented to him Leontius Pilatus of Thessalonica, who was then teaching him Greek. The lover of Laura had formerly studied that language under Barlaam, a monk, the ambassador of the Emperor Andronicus to Benedict XII., but he had studied it only in the dialogues of Plato; and, from the short stay of the monk at the court of Avignon, there is some reason to believe that, under Barlaam, he learned more Platonism than Greek. But however this may have been, he availed himself of the opportunity thus afforded him to resume the study of that language; and though now past sixty, he found, even in the difficulties which opposed his progress, sufficient enjoyment to mitigate the affliction caused by the loss of many valued friends. It was the fortune of Petrarch to survive all those whom he loved. In the course of fifteen years, death had deprived him of Cardinal John Colonna, James of Carrara, lord of Padua, and several other friends who were not less dear to him, but who are now less known; and this second pestilence bereft him of almost all those who remained, particularly of Azon de Corregio, and two other gentlemen who had shared with him the friendship of the Bishop of Lombez, and who are so often mentioned in his letters under the names of Lælius and Scipio. His grief was profound, and, under the depression it occasioned, he became more sensitive to the criticisms which, notwithstanding his reputation, were freely made on his Latin eclogues, and on some parts of his *Africa*. It was then that the poet wept over his laurels, and, in the bitterness of a wounded spirit, confessed that his crown had been to him a crown of thorns.

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[1] Morelli, *Della Publica Libreria di S. Marco*, p. 4 et seq. Venice, 1774, in 4to.

[2] Several of these books, which had lain forgotten for nearly three centuries, fell to dust when touched, and others were found, as it were, petrified. Tomasini, in his *Petrarcha Redivivus* (p. 65), gives a list of those which, in 1635, were found in good condition. Amongst these he remarked a Polyglot Vocabulary in Latin, Persian, and Turkish (*Comanicum*), written in the year 1303, of which he transcribed a small specimen.

Morelli, in the work already referred to, gives a detail of several of these manuscripts, which are still to be seen in the library of St Mark, and accounts for the oblivion into which they had been allowed to fall during so long a period, from the enthusiasm which the acquisition of the Greek manuscripts of Cardinal Bessarion excited in the fifteenth century.

The homage which was paid to him at Venice might, however, have afforded him some consolation, had not a new revolt in the island of Candia created serious alarm in the mother country. The senate, confiding in the military reputation and experience of Luchino del Verme, a Milanese general, the friend of Petrarch, appointed him to the command of the expedition fitted out against the rebels; and the poet consented to support the application made by the doge to that officer. Luchino put down the insurrection; and Petrarch had a place assigned him, on the right hand of the doge, at the equestrian games which were celebrated, in the manner of the ancients, in honour of this victory. Urban V., a virtuous and enlightened pontiff, now attempted to recall the poet to his court, by conferring upon him a canonship at Carpentras; a favour which he repaid by urging the holy father, in a long and vehement letter, to put an end to celibacy in the Roman Catholic church. Meanwhile, the cry of hatred raised everywhere against the Visconti had armed against them the new pontiff, and with him the half of Italy, now menaced by their ambition. Much less alarmed at this danger, however, than apprehensive of a war which would expose his country to the ravages of a foreign soldiery, Petrarch was employed by Galeas Visconti to endeavour to avert the storm; and this, which proved the last, was also the most fruitless of all his missions. But the warmth with which he defended the Visconti family in no degree diminished the favour he enjoyed at Rome. Urban wished to see him; and Petrarch was preparing to respond to an invitation conceived in terms the most urgent and flattering, when he was seized with a terrible malady at Ferrara. But though saved by the care of the Este family, who governed that country, he did not recover sufficient strength to continue his journey; and having returned to Padua, reclining upon a couch in a boat, he established himself four leagues from that city, at the village of Arqua, situated in the Euganean hills, so celebrated by the Romans for the salubrity of the air, the richness of the pasturages, and the beauty of the orchards. There the poet resumed, with his labours, all the imprudence of his usual course of life. Employing at once as many as five secretaries, he exhausted himself with austerities, restricted himself to a single repast composed of fruits or pulse, abstained from wine, fasted often, and, on days of abstinence, allowed himself only bread and water. An unforeseen event also served to retard his convalescence. Urban V., preferring the peaceful abode of Avignon to the tumultuous agitations of Rome, had returned to die in France. He was succeeded by Gregory XI., who, equally well affected towards Petrarch, chose, as his legate in Italy, Philip de Cabassole, now cardinal and archbishop of Jerusalem. But this prelate died soon after reaching Perugia, and Petrarch never more beheld the beloved friend of his youth. The poet, however, appeared to revive on receiving a libel published by a French monk against his letter of congratulation to Pope Urban, and he once more humbled himself so far as to reply to an invective by abuse.

Francesco de Carrara, abandoned by his allies, had just concluded a humiliating peace with Venice. Being obliged to send his son to ask pardon and swear fidelity to the republic, he entreated Petrarch to accompany the youth, and address the senate in his behalf. Though sick and old, the poet only recollected his ancient friendship for the lords of Padua, and repaired with young Carrara to Venice. The day after their arrival they had an audience; but the old man, overcome with fatigue, and perhaps awed by the majesty of the assembly, could not utter a word. The following day, however, he took courage, and his harangue was warmly applauded. But this effort proved his last; it was the song of the swan when dying. He returned to Arqua, feeble, exhausted, and as indocile to the counsels of physicians as ever. Boccacio, who now seemed to supply the place of all the friends he had lost, having sent him the Decameron, which had just been completed, Petrarch read it with enthusiasm; got by heart the novel of Griseldis, which he translated into Latin; and transmitted to Boccacio this version, accompanied with a letter, which appears to have been the last he ever wrote. On the 18th of July 1374, he was found dead in his library, with his head resting upon an open book, an attack of apoplexy having seized him in that attitude. All Padua came to assist at his obsequies. Francesco de Carrara conducted the funeral ceremonies, attended by the nobility and the people; and the family of the poet caused a mausoleum of marble to be erected to his memory before the gate of the church of Arqua.[1]

The illustrious subject of this notice was connected with all the celebrated men of the fourteenth century; he took part in almost every event by which that memorable age was distinguished; and in a life so full of trouble and agitation, the only reproach which he incurred constitutes

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[1] This simple narrative will enable the reader to appreciate the truth and beauty of the following exquisite stanzas in the fourth canto of *Childe Harold:*

There is a tomb in Arqua; rear'd in air,
Pillar'd in their sarcophagus, repose
The bones of Laura's lover: here repair
Many familiar with his well sung woes,
The pilgrims of his genius. He arose
To raise a language, and his land reclaim
From the dull yoke of her barbaric foes:
Watering the tree which bears his lady's name
With his melodious tears, he gave himself to fame.

They keep his dust in Arqua, where he died;
The mountain village where his latter days
Went down the vale of years; and 'tis their pride—
An honest pride—and let it be their praise,
To offer to the passing stranger's gaze
His mansion and his sepulchre, both plain
And venerably simple, such as raise
A feeling more accordant with his strain
Than if a pyramid form'd his monumental fane.

On the subject of Petrarch's love, which Gibbon calls "a metaphysical passion for a nymph so shadowy, that her existence has been questioned," and also in regard to the last circumstances in the life of the poet, the reader will find some curious information in those of the notes to this canto which refer to the stanzas above quoted.

the finest eulogium on his character. He was born a poet, and always continued so, in his studies, his political missions, his love, his conversation, and his letters. The love of his country was no doubt in him little more than a poetical dream, but it was the dream of his whole life. In the intoxication of glory, as well as in the midst of the most cruel afflictions, ancient Italy was ever present to his thoughts. In the glorious recollections of the past he sought to console himself for the disorders of his own age, and from his worship of antiquity he derived generous inspirations and innocent illusions. That these illusions sometimes misled him in the choice of his friends, cannot reasonably be questioned. His candour exposed him without defence to the calculations of an astute policy, which, masking its real designs under the captivating name of Italy, completed the deception by the interested benefits which it conferred upon letters; but he passed through the courts of the petty Italian tyrants without any one having impeached his character, or cast a shade of suspicion on his memory. His morals were not entirely pure, but they were never corrupt. In his youth he had a natural daughter, near whom he died soon after her marriage; and his son, whom he survived, was cherished with an affection and bewailed with a sorrow that long served to keep alive the regret which the remembrance of his weaknesses had left in his mind. The lover of Laura was impressed with a deep sense of religion; and, amongst the habits of a simple and studious life, it is related that he rose regularly at midnight for prayer. Superior to the pedantry which then and long afterwards clung to learning, this great poet was also an amiable man. His conversation was confiding and animated; his manners were frank and polished. His soul, ardent, but open to all the gentler affections, had a natural craving for friendship, which was to him a necessary of life; and he had many friends, all of whom appear to have been faithful to him, and equally swayed by the double authority of his counsel and his example. Boccacio, whose benefactor he had been, and who had previously been little else than a man of pleasure, became irreproachable, if not austere, in his morals, after his acquaintance with Petrarch. Acciaiuoli, grand seneschal of Naples, having become embroiled with another friend of Petrarch, the latter wrote to both a letter which was only to be opened and read in common, and the consequence was, that they parted mutually reconciled. It was by means of his friends that Petrarch exercised a kind of literary dictatorship in France, in Spain, and in England; it was through his friends that he was enabled to carry on that European correspondence which everywhere rekindled the study and admiration of the ancients. This long supremacy, scarcely disturbed by some clamours which envy had excited, and the honours paid to his memory throughout all Italy, gave a general impulse to the minds of men. He represented in his own person the republic of letters, and his life forms a grand epoch in their history. The elevation of his character made them be respected by the great; whilst his writings contributed powerfully to purify them from that strange alloy with which ignorance had debased them.

He studied with diligence alchemy, astrology, scholastic theology, and Aristotle, with his interpreter Averroes, who had then even more authority than the great master before whom philosophy is said to have stood dumb. Even at the time when, by his advice, Galeas Visconti founded the university of Pavia, he himself directed the course of study, and formed the mind of Malpighino, who afterwards became so famous amongst the restorers of letters by the name of John of Ravenna. His letters *De Scriptis Veterum Indagandis* and *De Libris Ciceronis* attest the extent of the researches he made to recover manuscripts of the ancient authors, which he then copied with his own hand, not venturing to intrust them to the ignorance of vulgar scribes. It was thus that he restored to the literary world the Oratorical Institutions of Quinctilian, though incomplete and mutilated, and the letters of Cicero, the manuscript of which is preserved in the Laurentian Library at Florence, with the copy which he had made from it. He equally recovered some of Cicero's orations which had been lost; and it is further known that he had preserved the famous treatise *De Gloria;* but having lent it to his master Convennole, this old man sold it for subsistence, and Petrarch afterwards attempted in vain to trace it out, as well as the Antiquities of Varro, which he had seen in his youth, and a book of letters and epigrams ascribed to Augustus. It was he also who first made Sophocles known in Italy; and his avidity for manuscripts had become so generally understood, that he received from Constantinople a complete copy of the poems of Homer, without having even asked for it. After the gift which he made to Venice, as already mentioned, he lost no time in forming another library. In an age when chronology and geography were still unknown, he had made a chronological collection of imperial medals, and got together a very considerable number of geographical charts. He himself was the author of a map of Italy, which continued to be consulted a century after his death; and all his biographers have mentioned his researches respecting the island of Thule. In a word, his name, which is inseparable from those of Dante and Boccacio, would alone be sufficient to refute the assertion, too often repeated, that the revival of letters was a consequence of the capture of Constantinople by the Turks in the year 1453.

It is no doubt true, that the rest of Europe did not then possess men who had attained the same splendour and universality of fame. France, which had received from her troubadours the oldest modern literature, could only boast of a few learned men; such as Nicolas Oresme, who enjoyed the esteem of Petrarch, but is better known by his translations, and by a discourse in which he denounced to the pope himself the scandals of the pontifical court; and Pierre Berchoire, author of a kind of encyclopædia, compiled in the spirit and style of the schools, and which he appears to have composed at Avignon. King John, and after him Charles V. collected the first volumes of the Royal Library; and Froissart, who by his simple and artless history does so much honour to the literature of France, commenced, under the latter prince, that series of French poets which has never since been interrupted. The praises of Laura diffused amongst the women a taste for Italian poetry; and one lady, whose name still survives in literary history, Justina de Levis, addressed a sonnet to Petrarch, which elicited from his gallantry or judgment warm commendation. Chaucer, who was preparing to found a literature in England, saw him in Italy, and was perhaps indebted to him for the acquaintance of Boccacio, whom he has so frequently imitated in his works. Another Englishman, Richard de Bury, one of the correspondents of Petrarch, founded a library at Oxford, and diffused throughout his country a taste for books. As yet Spain had only her early historical romances, and some theologians; but two centuries later, the poetical admirer of Laura found in Boscan an imitator at the court of Castille, whilst Bembo, Tarsia, Molsa, and many others, opened in Italy the dangerous school of the Petrarchists.

The Letters of Petrarch, which were printed for the first time in 1484, though without the name of the place, are now regarded as the most curious portion of his Latin works. These letters, which were not written exclusively for his friends, contain valuable details in regard to his life, as well as the manners and the history, literary and political, of the fourteenth century. The court of Avignon is by no means spared; and the author was too good an Italian not in some instances to overcharge a little his portraits. His expression is animated, but not always natural, and his prose often betrays the poet. His books of moral philosophy somewhat resemble those common-places which were treated by the Greek rhetoricians of the middle age. That which he has entitled Remedies against both kinds of Fortune has for its object to show, that earthly goods are perishable, and that there exists no evil without a remedy.[1] The treatise *De Otio Religiosorum* was a tribute of complaisance to the Carthusian friars of Montrieu, amongst whom his brother had taken the habit of the order;[2] and it was at the urgent entreaty of Francesco de Carrara that he collected the principal maxims of Plato and Cicero on politics, under the title of *De Republica optime administranda*, which might have suited a more methodical and extended composition. The compilation in question, and his treatise *De Officio et Virtutibus Imperatoris*, were printed separately at Berne, 1602, in 12mo; and though these little works have since been effaced by so many other superior productions, yet they are the offspring of a judicious mind, which neither flattered authority on the one hand, nor disregarded the rights of mankind on the other. In his retreat at Arqua, he also wrote a truly philosophical work against the disciples of Aristotle, under this piquant denomination, *De Ignorantia sui ipsius et multorum*. His Historical Essays, of which some fragments have been preserved, entitled *Rerum Memorandarum libri iv.*, in addition to the facts which he has borrowed from preceding writers, contain some particulars belonging to contemporaneous history, which are nowhere else to be found. The perusal of the Confessions of St Augustin appears to have suggested to him the most singular of all his compositions, namely, the three dialogues, *De Contemptu Mundi*, to which he attached so much importance as to call them "his secret." The author communes with St Augustin on his own character, tastes, and weaknesses; he confesses his faults with the simplicity of childhood, and, on the other hand, St Augustin lectures him with an authority tempered by mildness, and a dignity softened by sympathizing benevolence.

The harangues of Petrarch are not always exempt from declamation, and, more than any of his other productions, betray the influence of the false taste against which he so successfully strove. But his Latin poetry has particular claims to the attention of men of letters. His poem of *Africa* has been compared to those pictures and statues, the productions of the infancy of art, which, without augmenting its glory, may be examined with advantage by those who desire to study its progress. It is a detailed recital of the second Punic war, but almost always cold and colourless. It is a chronicle rather than a poem, and appears as if it had been left unfinished. The *mens divinior* is wanting; invention there is none; and we are astonished to find that the poetry of Virgil produced so little inspiration. His eclogues, like those of Boccacio, are almost always satirical allegories, having reference to contemporaneous events. The tenth is consecrated to the memory of Laura. In his three books of Epistles, versified with more facility than might have been expected in that iron age, there are some interesting and instructive details. In fact, the Latin diction of Petrarch, though generally superior to the bald and rude style of his contemporaries, is nevertheless far below that of his models. His composition is vigorous without being harsh, and on some occasions he is deficient neither in elegance nor in energy; but he more frequently reminds us of St Augustin than of Cicero, whom he professed not only to admire, but to imitate. Still, it was on his Latin works that Petrarch founded his claims to distinction as an author; and, what is not a little remarkable, this was also the error of Boccacio. These misjudgments of genius, of which we have examples both in Homer and in Milton, as well as in the two illustrious men we have just named, would form a curious subject of literary speculation, were this the place in which it could with propriety be discussed.

But Petrarch's best title to distinction rests upon his *Canzoniere*. It is there that he shows himself truly inspired, and displays in profusion all the riches of his original genius. The ancient erotic poets, strangers to any ennobling sentiment, had celebrated pleasure rather than love. That respect for women which had so long existed amongst the nations of the North; that worship of beauty, ennobled by the still recent recollections of chivalry; those feats of valour which were days of triumph to the ladies; all this was wanting to pagan society. Petrarch, therefore, stands alone, because his passion resembled nothing which the ancients had known. The early songs of the troubadours had embodied the natural expression of the manners of chivalry. The examples which they had presented, the traditions which they had left, as well as the unfortunate refinements of the Italians, their imitators, and the idle subtleties of the courts of love, a sad parody of the forms, and often of the obscurities, of the schools, had created amongst the moderns a language to which rhyme added its shackles; a language which was no longer the vulgar language, but yet was not that of poetry. To this the lover of Laura imparted all that the superiority of his genius had taught him. We have seen that he had studied Plato. But although his mind had, unaided, divined the disciple of Socrates, yet that union of souls which the philosopher had sometimes dreamed of was as remote from the sentiment which inspired Petrarch as the domestic manners of the Greeks differed from those of the fourteenth century. It was not Platonic love which had animated the poet; it was love such as Christianity and chivalry had made it. This love, which the corruption of our age has pronounced supernatural, is poetical in a very different sense from that which inspired Propertius and Ovid. It no doubt wants movement and variety; but it has a true and penetrating warmth, an elevation which rises to the sublime, and a purity which has in it something almost celestial. Petrarch was the first, and for a long time the only poet, who made a virtue of love. The Italian, created by Dante, had even after his time retained somewhat of that harshness which is still apt to shock the reader in some parts of his *Inferno*. Petrarch formed for himself a language, as Dante had done; his turns of expression are almost as bold; above all, he reproduced those graces of colouring and that delicious harmony with which Dante had related the misfortunes of his Francesca; and, after the publication of the *Canzoniere*, the Italian idiom ceased to have in it any thing barbarous. When we read the verses of Petrarch, we can almost fancy that we hear the sound of his lyre, from which, on every occasion, he extracts sounds of an ineffable sweetness. In the first part, where he celebrates the perfections of Laura, his expression becomes dreamy or ecstatic; in the second, where he laments his mistress, his song has a solemn and penetrating accent. Sometimes he lends his lute to chant the lessons of philosophy; at other times it is the Hebrew harp resounding the maledictions of the prophets, or a Roman muse bewailing the debasement and misfortunes of her country. Those who love comparisons and coincidences have remarked, that the sonnets, from their form, remind us of some of the smaller odes of Horace, and, for grace as well as simplicity of details, recall the manner of the poet of Teos. For this kind of poetry Petrarch was indebted to his predecessors; but it was he who rendered these little poems more perfect and more difficult; and the laws which his example prescribed have not yet been abrogated.

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[1] In the *Archives Littéraires* (tom. ii. pp. 259-286), M. de Gerando has translated some fragments of this very common-place dialogue under the title of the Philosophy of Petrarch (*De la Philosophie de Pétrarque*).

[2] Several biographers have given Petrarch a sister, who, they say, was beloved by Pope Benedict XII. This fable, which has been received without question by Protestants, and thoughtlessly repeated by Villaret, and even by Henry, is disproved by the fact, which Ginguené has clearly established, namely, that Petrarch never had a sister.

The *Canzoni* of Petrarch, which have been improperly rendered *Chansons* by Voltaire, are odes the form of which he borrowed from the troubadours, whilst to the substance he imparted the elevation and dignity of epic composition. The Italians have exhausted all the prescriptive terms of admiration upon those which Petrarch appears to have preferred, and which he called the Three Sisters, odes which his commentators have since named the Three Graces. The eyes of Laura form the subject of these three odes, which are the eighteenth, nineteenth, and twentieth of the collection. But whatever may be the perfection of style for which they are distinguished, a reader of the present day will always find difficulty in comprehending the long literary superstition of which they have been the object. Graver readers will no doubt prefer the *Canzone* on the crusade, which is the fifth in the collection, and that magnificent ode, so truly national, in which the poet retraces, *en traits de feu*, the oppression of his beloved Italy, and shows her bleeding and mutilated, yet still full of glory, and capable of recovering from her wounds; compositions so little known to those superficial *littérateurs* who have mistaken a man of the greatest genius, who formed a language and created a literature, for a mere grinder of madrigals. All those who know the language of Petrarch have cited, amongst the monuments of his love, the celebrated sonnets,

> Solo e pensoso i più deserti campi
> Vo misurando a passi tardi e lenti;
> E gli occhi porto, per fuggire, intenti
> Dove vestigio uman la rena stampi,

being the twenty-eighth of the first part; and

> Levommi il mio pensier in parte ov'era
> Quella ch' io cerco e non ritrovo in terra:
> Ivi fra lor che 'l terzo cerchio serra,
> La rividi più bella, e meno altera,

which is the thirty-fourth of the second part; besides many other *Canzoni* not less admired, amongst which it would be difficult to make a selection. We shall only refer our readers to the twenty-seventh, the first strophe of which has been so happily imitated by Voltaire. The latter, however, has not been equally fortunate in his judgment of Petrarch; and Sismondi, without indulging in the same levity, has shown himself almost equally severe. But the monotony with which Petrarch has been reproached is perhaps rather a defect inherent in the particular species than one peculiar to the poet. The lover of Laura bewails himself, since complain he must, and this eternal lamentation is without doubt sometimes fatiguing; but love rejoices in such repetitions; and Petrarch has varied as much as possible this uniformity, by pictures of rustic life full of natural grace and simplicity, or by high and ennobling religious contemplations. We do not say, however, that his poems, and especially his sonnets, have escaped all tincture of the prevailing taste of his age. On the contrary, he is often more ingenious than natural, and more elaborate than correct; but a re-perusal of the second half of the *Canzoniere*, which is very generally preferred to the first, must satisfy any reader that nothing short of extreme injustice or inveterate prejudice can construe into a mere play of words or sport of ingenuity a grief which is stamped with all the characteristics of truth, deep feeling, and sincerity.

The most complete edition of the works of Petrarch is that of Basel, 1581, in folio, which wants only a certain number of Letters, comprised in that of Geneva, 1601. The most ancient edition of his Latin works also bears the name of Basel, where it appeared in 1496, in folio. But it is in the libraries of Italy that his Letters and his Autograph Manuscripts must be sought for. The treatise De Remediis utriusque Fortunæ was printed at Cologne, 1471, in 4to, and has been thrice translated into French; and the historical work entitled Vite de' Pontefici et Imperadori Romani, which has now become exceedingly scarce, appeared at Florence, 1478, in folio, and is still much sought after, as one of the most ancient monuments of Italian prose. In later times, his Italian poems alone have been reprinted. The first edition, containing the Sonetti and the Trionfi, is that of Venice, 1470, in large 4to. Amongst the subsequent editions, the most esteemed are, 1. Le Cose Volgari, by Aldus Manutius, Venice, 1501, in 8vo; 2. Il Petrarca, Lyons, 1574, in 16to; 3. Le Rime di Petrarca, Padua, 1722, in 8vo; 4. A reprint of the same, with notes by Muratori, Venice, 1727, in 4to; 5. The editions of Bodoni, 1799, in two vols. folio and 8vo; 6. That of Morelli, the librarian, with Remarks by Beccadelli, Verona, 1799, in two small vols. 8vo; 7. That which forms part of the Biblioteca Poetica Italiana, published by Buttura, and printed by Didot the elder, Paris, in three small vols.; and, 8. The edition, with Commentaries, published by Biagioli in 1822, in 8vo. Petrarch is said to have been the subject of twenty-five distinct biographies, exclusive of the sketches of his life given in collections. Of these lives, the most copious, though by no means the most accurate, is that of the Abbé de Sade; and as to Lord Woodhouselee's Historical and Critical Essay on the Life and Character of Petrarch, published in 1810, Lord Byron has dryly remarked, "Thanks to the critical acumen of a Scotchman, we know as little of Laura as ever." (A.)

PETREL ISLAND, a small island in Dusky Bay, near the coast of New Zealand, a little to the north of the harbour in Anchor Island. It is also the name of a bay on the south coast of New Holland. Long. 133. 15. 30. E. Lat. 32. 33. 30. S.

PETRIFACTION, in *Natural History*, denotes the conversion of wood, bones, and some other substances, whether animal or vegetable, into stone. These bodies are more or less altered from their original state, according to the different substances amongst which they have lain buried in the earth; some of them having suffered very little change, and others being so highly impregnated with crystalline, sparry, pyritical, or other extraneous matter, as to appear mere masses of stone or lumps of the matter of the common pyrites. But they are generally of the same external dimensions, and retain more or less of the same internal figure, as the bodies into the pores of which this matter has made its way. The animal substances thus found petrified are chiefly sea-shells, the teeth, bony palates, and bones of fishes, the bones of land-animals, and some others. These are found variously altered, by the insinuation of stony and mineral matter into their pores; and the substance of some of them is found to be wholly gone, leaving only stony, sparry, or other mineral matter remaining in the original shape and form.

Respecting the manner in which petrifaction is accomplished, we know but little. It has been thought by many philosophers, that this is one of the occult processes of nature; and accordingly such places as afford a view of it have been looked upon as great curiosities. However, it is now discovered that petrifaction is exceedingly common, and that every kind of water carries in it some earthy particles, which being precipitated, become stone of a greater or less degree of hardness; and this quality is most remarkable in those waters which are much impregnated with selenitic matter. It has been found by observation, that iron contributes greatly to the process; and this it may do by its precipitation of any aluminous earth which happens to be dissolved in the water by means of an acid, iron having the property of precipitating this earth. Calcareous earth, however, by being soluble in water without any acid, must contribute greatly to the process of petrifaction, as its particles are capable of acquiring a great degree of hardness by means only of being joined with fixed air, on which depends the solidity of our common cement or mortar used in building houses.

The name of petrifaction, as we have seen, belongs only to bodies of vegetable or animal origin; and in order to determine their class and genus, or even species, it is necessary that their texture, their primitive form, and in some measure also their organization, should be still discernible. Thus, we ought not to place the stony kernels, moulded in the cavity of some shell, or other organized body, in the rank of petrifactions properly so called.

Petrifactions of the vegetable kingdom are almost all either gravelly or siliceous; and they are found in gullies, trenches, and other situations. Those which strike fire with steel are principally found in sandy fissures; those which effervesce in acids are generally of animal origin, and are found in the horizontal beds of calcareous earth, and sometimes in beds of clay or gravel, in which last case the nature of the petrifaction is different. As to the substances which are found in gypsum, they seldom undergo any alteration, either with respect to figure or composition, and they are of very rare occurrence.

Organized bodies, in a state of petrifaction, generally acquire a degree of solidity of which they were not possessed when they were buried in the earth, and some of them are often fully as hard as the stones or matrices in which they are enveloped. When the stones are broken, the fragments of petrifactions are readily found, and easily distinguished. There are some organized bodies, however, so changed by petrifaction, as to render it impossible to discover their origin. That there is a matter more or less agitated, and adapted for penetrating bodies, which crumbles and separates their parts, and disperses them here and there in the fluid which surrounds them, is a fact of which nobody seems to entertain any doubt. Indeed we see almost every substance, whether solid or liquid, insensibly consume, diminish in bulk, and at last, in the lapse of time, vanish and disappear.

A petrified substance, strictly speaking, is nothing more than the skeleton, or perhaps the form, of a body which has once had life, either animal or vegetable, combined with some mineral. Thus, petrified wood is not, in that state, wood alone. One part of the compound or mass of wood, having been destroyed by local causes, has been compensated by earthy and sandy substances, diluted and extremely minute, which the waters surrounding them had deposited, whilst they themselves evaporated. These earthy substances, being then moulded in the skeleton, will be more or less indurated, and will appear to have its figure, structure, and size, in a word, the same general characters, the same specific attributes, and the same individual differences. Further, in petrified wood, no trace or vestige of ligneous matter appears to exist. We know that common wood is a body in which the volume of solid parts is greatly exceeded by that of the pores. When wood is buried in certain places, lapidific fluids, extremely divided and sometimes coloured, insinuate themselves into its pores and fill them up. These fluids are afterwards moulded and condensed. The solid part of the wood is decomposed and reduced into powder, which is expelled from the mass by aqueous filtrations; and thus the places which were formerly occupied by the wood are now left empty in the form of pores. This operation of nature produces no apparent difference either of the size or of the shape; but it occasions, both at the surface and in the interior, a change of substance, and the ligneous texture is inverted, or, in other words, that which was pore in the natural wood becomes solid in the petrified, and that which was solid or full in the first state becomes porous in the second. In this way, says Musard, petrified wood is much less extended in pores than solid parts, and at the same time forms a body much denser and heavier than the first. As the pores communicate from the circumference to the centre, the petrifaction ought to begin at the centre, and end with the circumference of the organic body subjected to the action of the lapidific fluids. Such is the origin of petrifactions. They are organized bodies which have undergone changes at the bottom of the sea or the surface of the earth, and which have been buried by various accidents at different depths under the ground. See Mineralogy and Geology.

PETROBRUSSIANS, a religious sect, which took its rise in France and the Netherlands about the year 1110. The name is derived from *Peter Bruys*, a Provençal, who made a most laudable attempt to reform the abuses and remove the superstition which disgraced the beautiful simplicity of the gospel. His followers were numerous, and for twenty years his labour in the ministry was exemplary and unremitted. He was, however, burned in the year 1130, by an enraged populace, said to have been set on by the clergy.

The most noted of Bruys's followers was a monk named Henry, from whom the Petrobrussians were also called *Henricians*. Peter the Venerable, abbot of Clugny, wrote a treatise expressly against the Petrobrussians, in the preface to which he reduces their opinions to five heads. They denied that children before the age of reason can be justified by baptism, as it is our own faith that saves by baptism. They held that no churches should be built, an inn being as proper for prayers as a temple, and a stable as an altar; that the cross ought to be pulled down and burned, because we ought to abhor the instrument of our Saviour's passion; that the real body and blood of Christ are not exhibited in the eucharist, but merely represented by figures and symbols; and that sacrifices, alms, prayers, and the like, do not avail the dead. Langlois accuses the Petrobrussians of Manicheism, and says, they maintained two gods, the one good, the other evil; but this is rather an effect of his zeal for the Catholic cause, which led him to blacken its adversaries, than any real sentiment of the Petrobrussians.

PETROJOANNITES were followers of Peter John, or Peter Joannis, that is, Peter the son of John, who flourished in the twelfth century. His doctrine was not known until after his death, when his body was taken out of his grave and burned. His opinions were, that he alone had the knowledge of the true sense in which the apostles preached the gospel; that the reasonable soul is not the form of man; that there is no grace infused by baptism; and that Jesus Christ was pierced with a lance on the cross before he expired.

PETROLEUM, or Rock Oil, a thick oily substance exuding from the earth, and collected on the surface of wells, in many parts of the world.

PETRONIUS Arbiter, C. the author of a kind of romance, the earliest with which we are acquainted, was born at Massilia, and is supposed to be the same of whom some account is given by Tacitus (*Ann.* xvi. 18). As proconsul, he administered the province of Bithynia with considerable ability, and on his return to Rome he became the favourite of Nero, and the director as well as participator of all his pleasures. His influence with the emperor excited the envy and jealousy of Tigellinus, and that minister soon found an opportunity of putting an end to his connection with Nero. Petronius chose his own mode of closing his life, A. D. 67, that he might escape a severer punishment. There is no certainty, however, that this individual, of whom Tacitus gives an account, is the same with the author of the work of which fragments have come down to us; but even if he be not, still there is no doubt that he must have flourished about this period, from the classical purity of his language, and the general arrangement of his subject. The work is entitled *Satyricon;* and of it we have only some fragments, which seem to have formed part of a selection from his work. It contains the adventures of a certain freedman, Encolpius, sometimes of a tragical, sometimes of a comical nature, which gives an opportunity to the author of narrating fully the follies and vices of his age. There has been preserved a beautiful episode, the Matron of Ephesus and the Supper of Trimalchio, which admits us to the domestic circles of the noble Romans, and makes us acquainted with their voluptuous mode of life. The characters are well drawn; the whole idea of the scene is got up with much spirit as well as art; and there are some beautiful descriptions, which make us regret that he should have wasted his talents on common and obscene subjects. The obscenity of much that is preserved is of the most gross and licentious nature; but the beauty of his style, and the purity of his expressions, remind us of the classical period of Roman literature. The best edition is that of Burmann (Traj. ad Rhen. 1709).

PETROPAULOSKAIA, a fortress of Asiatic Russia, in the government of Irkoutsk, sixteen miles south-south-west of Selenginsk. Another fortress in the government of Oufa, 52 miles east-north-east of Verchouralsk. Also a town of Asiatic Russia, in the government of Tobolsk, on the Ischim, forty miles east of Ischim.

PETROSOWODSK, a city of Russia, in the government of Olonez, and the capital of a circle of its own name. It is situated on a bay of the Lake of Onega, and by means of the Salma is connected with the Lake of Lagmosero. It is poorly built, but contains 390 houses, mostly of wood, and 3280 inhabitants, who trade in pitch, tar, and ship-timber; and near it there are some large iron-works. It is 303 miles from St Petersburg. Long. 34. 18. 25. E. Lat. 61. 47. 4. N.

PETSCHANOI, a fortress of Asiatic Russia, in the government of Kolivan, 188 miles west-south-west of Kolivan. Also a cape on the northern coast of Asiatic Russia, in the Frozen Sea. Long. 165. 14. E. Lat. 75. 25. N.

PETTEIA, in the ancient music, a term to which we have no one corresponding in our language. The melopœia, or the art of arranging sounds in succession so as to produce melody, is divided into three parts, which the Greeks call *lepsis*, *mixis*, and *chresis;* the Latins, *sumptio*, *mixio*, and *usus;* and the Italians, *presa*, *mescolamento*, and *uso*. The last of these is called by the Greeks πεττεια, and by the Italians *pettia;* which therefore means the art of making a just discernment of all the manners of ranging or combining sounds amongst themselves, so that they may produce their effect, or express the several passions intended to be raised. Thus it shows what sounds are to be used, and what not; how often they are severally to be repeated; with which to begin and with which to end; whether with a grave sound to rise, or an acute one to fall, &c. The petteia constitutes the manners of the music; chooses out this or that passion, this or that motion of the soul, to be awakened; and determines whether it be proper to excite it on this or on that occasion. The petteia, therefore, is in music much what the manners are in poetry.

It is not easy to discover whence the denomination should have been taken by the Greeks, unless from πεττεια, their game of chess, the musical petteia being a sort of combination and arrangement of sounds, as chess is of pieces called πεττιο, *calculi*, or chess-men.

PETTIPORE, or PETTAPORE, a town of Hindustan, in the Northern Circars, and district of Rajamundry, thirty-three miles east-north-east from the town of Rajamundry. Long. 82. 25. E. Lat. 27. 5. N.

Petty.

PETTY, SIR WILLIAM, a man eminently distinguished for his learning, mechanical ingenuity, and political writings, was the eldest son of Antony Petty, a clothier at Rumsey, in Hampshire, where he was born on the 16th of May 1623. Petty, when a boy, was noted for the pleasure he took in observing mechanics at work, and the facility with which he comprehended the nature of their employments and the use of their tools. He received the rudiments of his education at the grammar-school of Rumsey, where, before the age of fifteen, he had acquired a competent knowledge of the Latin, Greek, and French languages, and made himself master of the common rules of arithmetic, as well as of the elements of geometry, dialling, and navigation. He then removed to the University of Caen, in Normandy, taking with him a small stock of merchandise, which he disposed of to so much advantage, that he maintained himself out of the profits of his traffic, and at the same time perfected himself in Latin and French, acquired enough of Greek "to serve his turn," studied the arts, and extended his knowledge of the mathematics. Even at this early period the prevailing bias of his mind displayed itself; and in the student of Caen we discover the father of the man who, holding that there are few ways in which a person may be more harmlessly employed than in getting money, afterwards realized a very great fortune. On his return from France, he was appointed to the navy, though in what capacity is not known. In this situation he remained for some time, and having saved about L.60, he determined to bid adieu to the navy, and travel for further improvement. Having made choice of physic as a profession, he, in 1643, visited Leyden, Utrecht, and Paris, where he studied anatomy, and read Vesalius with Hobbes, whom he in turn assisted by drawing diagrams for the philosopher, who was then writing on optics. Whilst at Paris he appears to have been reduced to great straits from want of money; but his ingenuity and industry extricated him from all his difficulties; and, in 1646, he returned home a richer man than when he had set out, although he had maintained his brother Antony as well as himself.

Petty was not a man to remain inactive or slothful. It appears indeed that, on the 6th of March 1647, a patent was granted him by parliament for an invention which would now be termed a copying-machine, but which he calls an instrument for double writing. In an advertisement prefixed to his Advice to Mr Samuel Hartlib, he describes it as an instrument of small bulk and price, easily made, and very durable, by means of which "any man, even at the first sight and handling, may write two resembling copies of the same thing at once, as serviceably and as fast as by the ordinary way;" and Rushworth informs us that it might be learned in an hour's practice, and was calculated to be of great advantage to lawyers, scriveners, merchants, scholars, registrars, clerks, and others, by saving the labour of examination, and discovering or preventing falsification. But this machine having been found not to promote expedition in writing, the principal advantage proposed to be attained by it, Petty did not reap much profit by his invention; but, although it failed of its object in this respect, it served to make him acquainted with the leading men of the times. His next production was a pamphlet entitled Advice to Mr Hartlib for the Advancement of Learning, containing some sensible remarks on national education, particularly in as far as regards the more useful branches of knowledge, which he justly conceived were too much neglected. In 1648 he went to Oxford, where he gave instructions in anatomy as a private teacher; became assistant to Dr Clayton, the professor of anatomy, who had an insurmountable aversion to the sight of a

Petty.

mangled corpse; and also practised physic with considerable success. Here he acquired such reputation, that the philosophical meetings which led to the institution of the Royal Society were for the most part held at his lodgings; and, by a parliamentary recommendation, he obtained a fellowship in Brazen-nose College, and was created doctor of physic on the 7th of March 1649. In June 1650, he was admitted a member of the College of Physicians; and the same year he was concerned in the recovery of a woman, named Anne Green, who had been hanged at Oxford for the supposed murder of her bastard child. In the beginning of 1651, he was appointed professor of anatomy, and soon afterwards professor of music, at Gresham College; and in 1652, he went to Ireland as physician to the army in that country, where he served under three successive lords-lieutenant, namely, Lambert, Fleetwood, and Henry Cromwell.

Some time after his settlement in Ireland, Dr Petty observing that the forfeited lands adjudged to the soldiers, after the suppression of the rebellion of 1641, were very inaccurately measured, represented the matter to the persons then in power; and a contract, dated the 11th of December 1654, was in consequence granted him, by which he was authorized to make the admeasurements anew, a duty which he appears to have discharged with exactness and fidelity. By this contract he gained a very considerable sum of money; for, besides the twenty shillings a day which he received during its performance, he had also, by agreement with the soldiers, a penny an acre for the lands measured by him; and by an order of government, dated the 19th of March 1655, it appears that he had then surveyed 2,008,000 acres, which, at the rate stipulated, must have yielded him about L.8400 sterling. He was likewise one of the commissioners for allocating the lands to the soldiers after they had been surveyed. In 1655, Henry Cromwell assumed the lord-lieutenancy of Ireland, and soon afterwards appointed Dr Petty his secretary; in 1657, the viceroy further appointed him clerk of the council, and got him elected to serve as burgess for West Love, in Cornwall, in Richard Cromwell's parliament, which assembled on the 27th of January 1658. But this last honour speedily involved him in trouble. On the 28th of March following he was impeached of high crimes and misdemeanours in the execution of his office, and obliged to proceed to England. On the 19th of April he appeared in the House of Commons, and answered to the charge on the 21st; the prosecutors then replied, after which the matter was adjourned, and never came to an issue, as the parliament was suddenly dissolved the next day. He soon afterwards returned to Ireland, where, some further attempts being made to bring on a prosecution, he published two pamphlets; the one giving an account of the proceedings in the impeachment, and the other containing reflections on some persons and things in Ireland. Finding the latter country getting too hot for him, he crossed over to England, provided with a warm application in his favour by the lord-lieutenant; but, notwithstanding this intercession, he was in June removed from all his employments.

The charges brought against him were six in number. He was accused of having received or taken great bribes; of having made a trade of buying debentures, contrary to the statute; of having obtained by fraud large sums of money and extensive tracts of land; of having employed many foul practices, as surveying and setting out lands; of having, along with his fellow-commissioners, placed some debentures in better situations than they could claim, and denied right to others; and, lastly, he and his fellow-commissioners were accused of having totally disposed of the army's security for payment, whilst the debt still remained chargeable on the state. Petty's answer to these charges is abundantly curious. Instead of trying to refute them in detail, he labours to show that, without ever intermeddling with the surveys of the Irish lands, he *might* have acquired as large a fortune by other means; and, certainly, whatever may be thought of such a defence to specific charges of malversation and fraud, the statement itself must be allowed the praise of ingenuity.

In 1659, the republican spirit not being yet extinct in Petty, he became a member of the Rota Club, which met at Miles's coffee-house, in New Palace-yard, Westminster. This club received its name from the strange practice it was intended to support, namely, that all officers of state should be chosen by ballot, that the time for holding their places should be limited, and that a certain number of members of parliament should be annually changed by rotation. But the star of the commonwealth was now waxing dim, and, not long after Christmas, Petty went to Ireland. At the Restoration, however, he came back to England, where he was graciously received by Charles II., and, having resigned his professorship at Gresham College, was appointed one of the commissioners of the Court of Claims. In April 1661, he received the honour of knighthood, with the grant of a new patent constituting him surveyor-general of Ireland; and he was at the same time chosen a member of the Irish parliament. Being one of the founders of the Royal Society, he was elected a member of the first council; and although he had left off the practice of physic, his name appears in the list of fellows of the College of Physicians in 1663. About this time he invented a double-bottomed ship, which was to sail against both wind and tide, though we are not told by what means; and, in 1665, he communicated to the Royal Society, along with a model of his invention, a Discourse about the Building of Ships, which being supposed to contain matter too important to be divulged, was taken away by the president, Lord Brounker, who kept it in his possession till 1682, and probably till his death, which happened not long afterwards.

In 1666, Sir William Petty drew up his treatise entitled *Verbum Sapienti*, containing an account of the wealth and expenditure of England, showing the method of raising taxes in the most equal manner, and endeavouring to prove, that England could bear a charge of four millions per annum, when the exigencies of the government required it. The same year he suffered a considerable loss by the fire of London, the greater part of his house and gardens having been destroyed by that terrible conflagration. In 1667, he married Elizabeth, daughter of Sir Hardresse Waller, and widow of Sir Maurice Fenton. This matrimonial connection, however, did not for a moment distract his attention from his favourite pursuit of making money; for immediately afterwards he established iron-works and a pilchard-fishery, opened lead mines, and commenced a trade in timber at Kerry, all of which turned to good account. To vary his pursuits, he also composed a piece of Latin poetry, which he subsequently published under the title of *Colloquium Davidis cum Anima sua*. In 1680, he gave to the world his Politician Discovered, intended to expose the sinister practices of the French; and afterwards wrote several essays on Political Arithmetic, in which, from considering the natural resources of England and Ireland, he shows how both may be strengthened, improved, and rendered superior to all their rivals or enemies. He assisted at the formation of the Dublin Philosophical Society, and in November 1684 was chosen president of that association. On this occasion he drew up a Catalogue of Cheap and Simple Experiments, which was soon afterwards followed by his *Suppellex Philosophica*, containing a description of forty instruments which he deemed necessary to carry forward the design of the institution. But the ultimate term of all his projects and pursuits was now approaching. A gangrene in his foot, occasioned by the swelling of the gout, having resisted every mode of treatment, at length put a period to his life, on the 16th of December 1687, in the sixty-fifth year of his age. He died at his house in Piccadilly, and his remains were interred at Rumsey, near those of his parents. His will is perhaps the most curious and characteristic composition of the kind in our language, illustrating at once the habits of thinking and feeling peculiar to the man, and the mode in which he realized the enormous fortune which he left to his descendants.[1]

A few particulars of the personal history of Sir William Petty may be gleaned from Aubrey, who appears to have lived with him on terms of intimacy. He possessed strong, shrewd, natural good sense, flavoured with a tincture of humour, and had a most convenient way of shaking himself rid of the trammels of party when it suited his interest to do so, changing sides with a facility that is altogether edifying. His qualifications were indeed various and peculiar. He was an excellent droll, as he showed by proposing to Sir Jerome Sankey, who had challenged him, to fight in a dark cellar with carpenters' axes; a proposal in which the knight, though he had been a soldier, did not deem it prudent to acquiesce. He would also preach extempore, which Aubrey says he did "incomparably," and that too in almost any style, "either in the presbyterian way, independent, capucin friar, or Jesuit." He had "an admirable inventive head, and practical parts," which he turned to good account as far as his own interest was concerned; and, like his friend Hobbes, he boasted that he had read but little since he was twenty-five, declaring, that "had he read as much as some men have, he had not known so much as he does, nor should have made such discoveries and improvements." He told Aubrey that he had "hewed out his fortune for himself," and he even managed to obtain a patent of nobility as Earl of Kilmore, which, however, he suppressed to avoid envy. The variety of pursuits in which he was engaged shows that he had talents capable of achieving any thing to which he chose to apply them; and it is certainly not a little remarkable, that a man of such an active and enterprising disposition should have found time to write so much as he did in the course of his busy life.

The following is a list of the works which appeared in his lifetime: 1. Advice to Mr Samuel Hartlib, 1648, in 4to; 2. A Brief of Proceedings between Sir Jerome Sankey and the Author, 1659, in folio; 3. Reflections on some Persons and Things in Ireland, 1660, in 8vo; 4. A Treatise of Taxes and Contributions, 1662, in 4to, republished in 1690, with two other pieces; 5. Apparatus to the History of the Common Practice of Dyeing, 1667; 6. A Discourse concerning Duplicate Proportion, 1674, in 12mo; 7. Colloquium Davidis cum Anima sua, 1679, in folio; 8. The Politician Discovered, 1681, in 4to; 9. An Essay on Political Arithmetic, 1682, in 8vo; 10. Observations upon the Dublin Bills of Mortality in 1681, 1683, in 8vo; 11. Some Experiments relating to Land-carriage, Phil. Trans. No. 161; 12. Queries on Mineral Waters, ibid. No. 166; 13. A Catalogue of Experiments, ibid. No. 167; 14. Maps of Ireland, being an actual Survey of the whole Kingdom, 1685, in folio; 15. An Essay concerning the Multiplication of Mankind, 1686, in 8vo; 16. A further Assertion concerning the Magnitude of London, Phil. Trans. No. 185; 17. Two Essays in Political Arithmetic, 1687, in 8vo; 18. Five Essays in Political Arithmetic, English and French, 1687, in 8vo; 19. Observations upon London and Rome, 1687, in 8vo.

His posthumous productions are, 1. Political Arithmetic, 1690, in 8vo, and 1755, with a Life prefixed, and a Letter never before printed; 2. The Political Anatomy of Ireland, to which is added, Verbum Sapienti, 1691, 1719; 3. A Treatise of Naval Philosophy, in three parts, printed at the end of an Account of Several New Inventions, 1691, in 12mo; 4. What a Complete Treatise of Navigation should contain, Phil. Trans. No. 198, drawn up in 1685. In Birch's History of the Royal Society are contained, 1. A Discourse of making Cloth and Sheep's Wool, containing the History of the Clothing Trade, and also that of Dyeing; and, 2. *Suppellex Philosophica*, already mentioned. There are many of Sir William Petty's manuscripts in the British Museum, amongst which is a sort of confession of his faith, corresponding with the concluding passage of his will, in which he says, "I die in the profession of that faith, and in the practice of such worship, as I find established by the law of my country," a very honest and candid declaration on his part. (A.)

PETTYCOTTA, a town of Hindustan, in the Southern Carnatic, and the province of Tanjore, thirty-two miles south by east from the town of Tanjore. Long. 79. 22. E. Lat. 16. 21. N.

PETWORTH, a market-town of the county of Sussex, in the rape of Arundel, and hundred of Rotherbridge. It is situated on the river Arun, fifty miles from London, and has a market which is held on Saturday. The streets are irregular, but the whole appearance is clean. The church is a fine object, and has a very lofty spire. The chief object of attraction is the magnificent mansion and park of the Earl of Egremont, the descendant of the celebrated Sir William Wyndham, to whom it, with other large estates, descended from the Percys, Earls of Northumberland, by a female branch. The population in 1801 amounted to 2264, in 1811 to 2459, in 1821 to 2781, and in 1831 to 3114.

PEWSEY, a town of the county of Wilts, in the hundred of Kinwardstone, seventy-six miles from London. The population in 1801 amounted to 1179, in 1811 to 1209, in 1821 to 1337, and in 1831 to 1588.

PEWSUM, a town of the kingdom of Hanover, in the province of East Friesland, the capital of a bailiwick of the same name, which extends over fifty-four square miles, and contains, besides the town, fourteen parishes, with 6320 inhabitants.

PEWTER, a factitious metal, used in the making of domestic utensils. The basis of this metal is tin, united to small portions of lead, zinc, bismuth, and antimony. There are three sorts of pewter in common use, distinguished by the names of *plate*, *trifle*, and *ley*. The plate-pewter is used for plates and dishes; the trifle, chiefly for pints and quarts;

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[1] As a specimen of this extraordinary composition, we shall take leave to introduce here the following extract, which appears to us to be eminently characteristic: "As for legacies for the poor, I am at a stand; as for beggars by trade and election, I give them nothing; as for impotents by the hand of God, the public ought to maintain them; as for those who have been bred to no calling or estate, they should be put upon their kindred; as for those who can get no work, the magistrate should cause them to be employed, which may be well done in Ireland, where is (are) fifteen acres of improvable land for every head; prisoners for crime, by the king; for debts, by their prosecutors; as for those who compassionate the sufferings of any object, let them relieve them, and relieve themselves by relieving such sufferings, that is, give them alms *pro re nata*, and for God's sake relieve those several species above mentioned, where the above-mentioned obligers fail in their duties: Wherefore I am contented that I have assisted all my poor relations, and put many in a way of getting their own bread, and have laboured in public works, and by inventions have sought out real objects of charity; and do hereby conjure all who partake of my estate, from time to time to do the same at their peril. Nevertheless, *to answer custom, and to take the surer side*, I give L.20 to the most wanting of the parish wherein I die." Here we have the domain of charity laid out by a political economist; and after the exclusion of the various classes above specified, it must be confessed that enough will scarcely remain to render it discernible on the map of the moral duties; though, "to answer custom and to take the surer side," a prudent Dives may, out of his enormous wealth, leave some L.20 to the most destitute of the parish wherein death separates him from all his earthly possessions.

and the ley-metal for wine measures, and the like. Our very best pewter is said to consist of a hundred parts of tin and seventeen of antimony, though others allow only ten parts of the latter metal. Besides this composition, there are other kinds, compounded of tin, antimony, bismuth, and copper, in several proportions.

PEYAUNG, a town of Hindustan, in the nabob of Oude's territories, seventy miles north-north-west from Lucknow. Long. 80. 15. E. Lat. 27. 40. N.

PEYRERE, Isaac la, an individual remarkable for versatility in his religious opinions, was born at Bordeaux in 1594, being the son of Protestant parents. He entered the service of the Prince of Condé, who was much pleased with the singularity of his genius. From the perusal of St Paul's writings, he took it into his head to maintain that Adam was not the first of the human race; and, to prove this heterodox opinion, he published a book, which was printed in Holland, and entitled *Præadamitæ, sive Exercitatio super versibus*, 12, 13, 14, *cap. xv. Epistolæ Pauli ad Romanos*, 1655, in 4to and 8vo. This work was burned at Paris, and the author imprisoned at Brussels, through the influence of the Archbishop of Malines's grand vicar. The Prince of Condé having obtained his liberty, he travelled to Rome in 1656, and there made to Pope Alexander VII. a solemn renunciation both of Calvinism and Preadamism. But his conversion was not thought to be sincere, at least with regard to this last heresy. His desire to be the head of a new sect is evident; and his book discovers his ambition, for he there pays many compliments to the Jews, and invites them to attend his lectures. Upon his return to Paris, notwithstanding the earnest solicitations of his holiness that he would remain at Rome, he went again into the service of the Prince of Condé, in quality of librarian. Some time afterwards he retired to the seminary *des Vertus*, where he died on the 30th of January 1676, at the age of eighty-two, after the sacraments of the church had been administered to him. Father Simon says, that when he was importuned in his last moments to retract the opinion which he had formed respecting the Preadamites, his answer was, *Hi quæcunque ignorant blasphemant.* His having no fixed opinions in religion is supposed to have proceeded more from a peculiar turn of mind than from corruption of heart; for good nature, simplicity of manners, and humanity, were the leading attributes of his character. "He was," according to Niceron, "a man of a very equal temper, and most agreeable conversation. He was a little too fond, however, of indulging his wit, which sometimes bordered on raillery; but he took care never to hurt or wound the feelings of his neighbour. His learning was extremely limited. He knew nothing either of Greek or of Hebrew, and yet he even ventured to give a new interpretation of several passages in the sacred volume. He prided himself upon his knowledge of the Latin; but, excepting a few poets which he had read, he was by no means an adept in that language. His style is very unequal; sometimes swelling and pompous, at other times low and grovelling." Besides the work already mentioned, he has left behind him, 1. a treatise entitled *Du Rappel de Juifs*, 1643, in 8vo; 2. an Account of Greenland, 1647, in 8vo; 3. an Account of Iceland, 1663, in 8vo; 4. a Letter to Philotimus, 1658, in 8vo, in which he explains the reasons of his recantation.

PEYROUSE, or Perouse, John Francis Galoup de la, the celebrated but unfortunate French navigator, was born at Albi in the year 1741. His father intended to train him up to a maritime life, for which purpose he sent him, when very young, to the marine school, where he became enthusiastically attached to his profession, and ambitious to emulate the fame of the most celebrated navigators. He was appointed midshipman on the 19th of November 1756, and behaved with great bravery in that station, having been severely wounded in the engagement between Hawke and Conflans on the 20th of November 1759. The *Formidable*, in which he served, was taken, after a vigorous resistance; and it is probable that Pérouse reaped some advantage from his acquaintance with British officers. He was promoted, on the 1st of October 1764, to the rank of lieutenant; and as he abhorred a life of ease and idleness, he contrived to be employed in six different ships of war during the peace between Great Britain and France. In 1776 he was promoted to the rank of master and commander. In 1779 he commanded the *Amazone*, belonging to the squadron of Vice-admiral Count d'Estaing; and when that officer engaged Admiral Byron, the duty assigned to La Pérouse was to carry the orders of the admiral to the whole of the line. He afterwards took the sloop *Ariel*, and contributed to the capture of the *Experiment*. In the year 1782, La Pérouse was sent with the *Sceptre* of seventy-four guns, and two frigates of thirty-six guns each, having some troops and field-pieces on board, to destroy the English settlements in Hudson's Bay; a task which he easily accomplished, as there was nothing on shore to oppose the smallest force. When he had destroyed the settlements, having learned that some of the English had fled at his approach into the woods, he generously left them provisions, and arms to defend themselves against the savages. In the year 1785, he was appointed to the command of some ships commissioned for a voyage round the world, which unfortunately proved his last. Of this voyage, as far as it was accomplished, full accounts have already been published, from which it is manifest that Pérouse was admirably qualified to discharge such a trust. He was an experienced and skilful seaman; skilled in mathematical and physical science; uncorrupted by that false philosophy which disgraced many of his attendants; and capable of the utmost perseverance in every commendable pursuit. To these valuable qualities he added caution and courage, with a disposition truly benevolent towards the savages whom he visited. Most of the calamities attendant on the voyage, with the exception of the last, were occasioned by the disobedience of his officers, or their neglecting to follow his advice. The last despatches received from this excellent man were dated from Botany Bay, the 7th of February 1788; but since that period no authentic account of him has ever been obtained.

PEYRUSSE, a city of France, in the department of Aveiron and arrondissement of Villefranche. It stands on an elevation, at the base of which flows the river Diège. It has a hospital, and 910 houses, with 6350 inhabitants. Long. 1. 55. E. Lat. 44. 36. N.

PEYTAHN, a district of Northern Hindustan, with a mountainous irregular surface, much covered with jungle. It is tributary to the rajah of Nepaul, and is situated about the twenty-ninth degree of north latitude. Also a town in the Nepaul territories, the capital of a district of the same name. Long. 82. 15. E. Lat. 29. 4. N.

PEZAY, N. Masson, Marquis de, born at Paris, where he early applied himself to the study of letters, and afterwards went into the army. He was made a captain of dragoons, and had the honour of giving some instructions in tactics to the ill-fated Louis XVI. Being appointed inspector-general of some coasting vessels, he repaired to the maritime towns, and executed his commission with more care and attention than was to be expected from a votary of the muses. But as he had at the same time displayed too much haughtiness, a complaint was made against him to the court, and he was banished to his country-seat, where he died soon afterwards, in the beginning of 1778. He was the intimate friend and companion of Dorat, whom he had studied, and successfully imitated; but his poems have more delicacy, and are less disfigured with trifling conversations of gallantry. He left behind him, 1. a Translation of Catullus, which is not much esteemed; 2. Les Soirées Helvetiennes, Alsaciennes, et Franc-Comtoises, 1770, in 8vo; 3. Les Soirées Provençales, in manuscript; 4. La Rosière de Salency, a pastoral in three acts, which was performed with success in the Italian theatres; 5. Les Campagnes de Mailebois, in three vols. 4to, and a volume of maps.

PEZENAS, a city of France, in the department of Hérault and arrondissement of Beziers. It is situated in a fine district on the river Peine, near to its junction with the Hérault. It contains 1600 houses, with 8640 inhabitants, who are employed in silk-mills, in tanneries, and in making brandy, soap, and other commodities. Long. 3. 21. E. Lat. 43. 28. N.

PFKOW, or Pleskow, a government or stadtholderate of the empire of Russia. It is formed out of a part of what was formerly Great Russia, or rather of the grand principality of Novogorod. It extends in north latitude from 55. 55. to 58. 4., and in east longitude from 27. 15. to 32. 1., having a superficies of 22,990 square miles. It is divided into eight circles, and comprehends ten cities or towns, and four hundred and thirty-five parishes. The population amounts to about 800,000 persons. The climate is severely cold, and the soil not fertile. The surface is covered with gentle elevations, woods, rivers, lakes, morasses, and heaths. The chief products, beyond what domestic consumption requires, consist of pitch, tar, flax, hemp, planks, masts, and flax-seed, which are conveyed to St Petersburg. The capital is the city of the same name situated on the Welikaja, is the see of an archbishop, with a cathedral, and fifty-nine other churches. It contains 1480 houses, constructed for the most part of wood, and about 10,000 inhabitants, whose chief trade is making sail-cloth and linen, and dealing in the raw products of their district. Long. 29. 5. E. Lat. 57. 40. N.

PHÆDO, a native of Elis, was the founder of the Eliac sect of philosophy, and the person whose name Plato inscribed in one of his most celebrated dialogues. The exact date of his birth and death is unknown, but he flourished B. C. 399. By the fortune of war he was taken prisoner, and reduced to a state of slavery. He was brought to Athens, where he became known to Socrates, who admired his talents so much that he caused Alcibiades or Crito to release him from servitude. He then became one of the most devoted attendants on his benefactor. It appears that he was not at all satisfied with the manner in which he was introduced by Plato into his dialogue; and he used to declare publicly that he had never spoken in that way, and that he had never heard Socrates use the language which Plato put into his mouth. Plato was so much offended with this proceeding, that, in revenge, he threatened to bring a lawsuit against Phædo, to prove that he had never received his freedom. (Athenæus, xi. 505, e; 507, c.) He composed several dialogues, the titles of which were, Zopyrus, Simon, and several which it was doubtful if they belonged to him; Nicias, Antimachus, Medus, ascribed by some to Æschines, by others to Polyænus; Sythici Sermones, ascribed also to Æschines; and three others quoted by Suidas. He was succeeded in his school by Pleistanus of Elis, Pleistanus by Stilpo, Stilpo by Menedemus of Eretria and Asclepiades of Phlius. (Diogenes Laertius's *Life of Phædo.*)

PHÆDRA, in fabulous history, was a daughter of Minos and Pasiphaë, who married Theseus, by whom she became the mother of Acamas and Demophoon. They had already lived for some time in conjugal felicity, when Venus, who hated all the descendants of Apollo, because he had discovered her amours with Mars, inspired Phædra with the strongest passion for Hippolytus, the son of Theseus by the Amazon Hippolyte. This passion she long attempted to stifle, but in vain; and therefore, in the absence of Theseus, she addressed Hippolytus with all the impatience of desponding love. He rejected her with horror and disdain. Incensed at the reception which she had met, she resolved to punish his coldness and refusal; and on the return of Theseus she accused Hippolytus of attempts upon her virtue. He listened to her accusation, and, without hearing Hippolytus's defence, banished him from his kingdom, and implored Neptune, who had promised to grant three of his requests, to punish him in an exemplary manner. As Hippolytus fled from Athens, his horses were suddenly terrified by a sea monster, which Neptune had sent on the shore; and he was thus dragged through precipices and over rocks, trampled under the feet of his horses, and crushed under the wheels of his chariot. When his tragical end became known at Athens, Phædra confessed her crime, and hung herself in despair, unable to survive one whose death had been occasioned by her licentiousness and falsehood. The death of Hippolytus, and the infamous passion of Phædra, form the subject of a tragedy of Euripides, and also of one by Seneca. She was buried at Trœzene, where her tomb was still to be seen in the time of the geographer Pausanias, near to the temple of Venus, which she had built to render the goddess favourable to her passion. Close by her tomb was a myrtle, the leaves of which were full of small holes, which, it was reported, Phædra had done with a hair pin, when the vehemence of her passion had rendered her melancholy and almost desperate. She was represented in a painting in the temple of Apollo at Delphi, as suspended in the air, whilst her sister Ariadne stood close by, with her eyes fixed upon Phædra.

Phædrus.

PHÆDRUS, the author of five books of fables, in Latin iambic measure, was a native of Thrace or Macedonia, and brought at a very early age to Rome, where he became the slave of Augustus, and from whom he subsequently received his freedom. The few facts that we know respecting his personal history are to be collected from his fables, as he is noticed by no earlier writer than Avianus, unless, perhaps, Martial may allude to him in one of his epigrams (iii. 20). If he really existed at this early period, it is strange that he should have been unknown to Seneca (*Cons. ad Polyb.* 27). By his long residence at Rome, Phædrus acquired a complete acquaintance with the language, and wrote it with as much ease as he could have done that of his own country. In the reign of Tiberius, he excited the wrath of Sejanus, and was banished by him, though for what cause we are nowhere distinctly informed. Under Caligula we find him in hopes of being reinstated in his position at court, through the influence of Eutychus. Part at least of these fables must have been written in the latter years of the poet, and not published till after the death of Sejanus. Schwabe, who has examined this point with great diligence, thinks that the first two books were written after the departure of Tiberius to Caprea, the third under Caligula, and the fourth and fifth under Claudius. One part of these fables consists of very happy translations of the Greek fables of Æsop into the Latin language, or imitations of them in verse, similar to that employed in the translations. The other part seems to have been original, or at least we have no longer the writers from whom he borrowed his subjects. The style is pure, the language remarkably correct, and the whole is written with simplicity and ease. Yet many have doubted whether these fables can be considered as the genuine productions of Phædrus, the freedman of Augustus, as we have so few manuscripts of the work, and as Seneca was evidently unacquainted with it. Some ascribe them to the pen of Nicolaus Perotti, archbishop of Manfredonia, who lived about the middle of the fifteenth century; but, in later times, the discovery of some manuscripts, one of which is considered as of the tenth century, has proved the incorrectness of such a supposition. The best edition of the works of Phædrus is that by Schwabe, two vols. Brunswick, 1806, 8vo.

PHÆNOMENON, in philosophy, denotes any remarkable appearance, whether in the heavens or in the earth, and whether discovered by observation or by experiment.

PHAETON, in fabulous history, was the son of Phœbus, and Clymene, one of the Oceanides. According to Hesiod and Pausanias, he was son of Cephalus and Aurora; or, according to Apollodorus, of Tithonus and Aurora. He is, however, more generally acknowledged to have been the son of Phœbus and Clymene. He was naturally of a lively disposition, and of a handsome figure. Venus became enamoured of him, and intrusted him with the care of one of her temples. But this distinguishing favour of the goddess rendered him vain and aspiring; and when Epaphus, the son of Io, had told him, to check his pride, that he was not the son of Phœbus, Phaeton resolved to know his true origin, and at the instigation of his mother he visited the palace of the Sun. He begged Phœbus, that, if really his father, he would give him incontestable proofs of his paternal tenderness, and convince the world of his legitimacy. Phœbus received him with great tenderness, and swore by Styx to grant whatever he requested, as a proof of his acknowledging him as his son. The youth boldly asked the direction of the chariot of the sun for one day. His father, grieved and surprised at this demand, used every argument to dissuade him from the rash attempt; but all was in vain; and being by his oath reduced to submit to the obstinacy of Phaeton, he intrusted him with the reins, after he had directed him how to use them. The young adventurer was, however, soon made sensible of his madness. Unable to guide the fiery steeds, he slackened the reins, upon which Jupiter, to prevent his consuming the heavens and the earth, struck him with a thunderbolt, and hurled him from his seat into the river Eridanus or Po. His sisters Phaëthusa, Lambetia, and Phœbe, lamenting his loss upon its banks, were changed by the gods into black poplar trees; and Cygnus, king of Liguria, also grieving at his fate, was transformed into a swan. The poets say, that whilst Phaeton was driving the chariot of his father, the blood of the Ethiopians was dried up, and their skin became black; a colour which is still preserved amongst the greater part of the inhabitants of the torrid zone. The territories of Libya were also, they tell us, parched up, on account of their too great vicinity to the sun; and ever since, Africa, unable to recover her original verdure and fruitfulness, has exhibited a sandy country and uncultivated waste. According to those who explain this poetical fable, Phaeton was a Ligurian prince, who studied astronomy, and in whose age the country situated on the Po was visited with uncommon heats.

PHAK, a district of Afghanistan, in the province of Cashmere. It is a romantic country, containing a beautiful lake, on which are some artificial islands. It is bounded on the west by the river Jhylum, and is situated in the thirty-fifth degree of north latitude.

PHALANX, in Grecian antiquity, a dense military formation, originally invented by the Greeks, but finally perfected by the Macedonians, under whom it became an invincible order of battle. See the article Army, in which the leading characteristics of this remarkable formation are fully explained.

PHALARIS, the tyrant of Agrigentum, of whom only a few facts have been transmitted to us, upon which any dependence can be placed. Ancient writers are not agreed as to the precise period when he began to reign, but Eusebius fixes the commencement of it B. C. 570, and his death B. C. 555. His father's name was Leodamas, a native of Astypalæa, an island in the Ægean Sea, where Phalaris was born. A dream of his mother is said to have prognosticated the cruelty of her unborn son. (Cic. *Div.* i. 23.) When he was grown to manhood, he made an attempt to seize upon the government of his native country, but was obliged to fly. He took refuge at Agrigentum, where he contrived to ingratiate himself with the people, and by a stratagem (Polyæn. v. 1) got possession of the supreme authority, which he exercised at first with much moderation. The Agrigentines, however, refused to submit quietly to his sway, and Phalaris found himself obliged to maintain by severity that power which he had so unjustly acquired. It is not unlikely that the ancients gave an exaggerated account of his cruelties, with the view of inspiring a hatred of tyranny. Athenæus speaks of his roasting children alive, and Aristotle states that he actually ate them; but such accounts can scarcely be credited. Perillus, an Athenian artist, is said to have constructed a brazen bull, in which the victims of Phalaris might be roasted; and when he expected to have been highly rewarded, the tyrant ordered him to be shut up in his own horrible machine. This story was doubted by Timæus (*Schol. Pind. Pyth.* i. 185), but Diodorus Siculus asserts its truth (xiii. 90, xix. 108). When Agrigentum was taken by the Carthaginians, they carried the bull to Carthage, and when that city was destroyed by Scipio Africanus, B. C. 146, it was presented by him to the Agrigentines. (Cic. *Verr.* iv. 33.) Authors are not agreed as to the mode of his death, but the most probable opinion is that the Agrigentines, tired of his cruelties, stoned him to death. (*Off.* ii. 7.) We possess a collection of letters under the name of Phalaris, which Boyle, who has edited them, tries to prove the genuine productions of the tyrant; but there can be no doubt that they were written by some of the later sophists. They were published for the first time by Justinopolitanus, at Venice, 1498, in 4to. The best editions are those of Oxford, 1695, 1718, in 8vo, with a Latin translation, notes, and a dissertation of Boyle on the life of Phalaris; and that of Groningen, 1777, in 4to, which was begun by Lennep and finished by Walkenaer. (See the Dissertation of Dodwell, *De Ætate Phalaridis;* and the Answer of Bentley.)

PHALERÆ, amongst the ancient Romans, were military rewards bestowed for signal acts of bravery. Authors are not agreed whether the *phaleræ* were a suit of rich trappings for a horse, or golden chains something like the *torques*, but so formed as to hang down to the breast, and display a greater profusion of ornament. The latter opinion appears to be the more prevalent one, but both are perhaps true.

PHALEUCIAN Verse, in ancient poetry, a kind of verse consisting of five feet; the first of which is a spondee, the second a dactyl, and the three last trochees.

PHANTASIA was the daughter of Nicarchus of Memphis in Egypt. It has been supposed that she wrote a poem on the Trojan war, and another on the return of Ulysses to Ithaca, compositions from which Homer is supposed to have copied the greater part of his Iliad and Odyssey when he visited Memphis, where they were deposited.

PHANTASM, a term sometimes used as synonymous with the idea or notion retained in the mind, of an external object. See Metaphysics.

PHANTASY, or Fancy, the imagination, one of the powers of the mind, by which the species of objects received through the external organs of sense are retained, recalled, further examined, and either compounded or divided. See Metaphysics.

PHANUEL, of the tribe of Asher, the father of a holy widow and prophetess called Anna, who was in the temple when our Saviour was presented there by his parents (Luke, ii. 36, 37, 38).

PHAON, a young man of Mitylene, in the island of Lesbos, who received from Venus, as fable reports, an alabaster vase filled with an essence which had the virtue of conferring beauty. He had no sooner anointed his body with it than he became the most beautiful of men. The ladies of Mitylene fell desperately in love with him; and the celebrated Sappho threw herself from the crest of a precipice because he refused to encourage her passion.

PHARAMOND is the name given by the generality of historians to the first king of France. He is said to have reigned at Trèves, and over a part of France, about the year 420, and to have been succeeded by his son Clodion; but the account which is given of these two princes is very uncertain. It is probable that Pharamond was no more than a general of an army, or the head of a military society of Franks, who were masters of their persons and their fortunes. Gregory of Tours, the author of a curious history of the Franks, appears to have entertained this opinion.

PHARAOH, a generic name of the kings of Egypt, belonging to the ancient native dynasties. Josephus says, that all the kings of Egypt, from Menes the founder of Memphis, who lived several ages before Abraham, always bore the name of Pharaoh, down to the time of Solomon, that is, for more than three thousand years. He adds, that in the Egyptian language the word *Pharaoh* signifies *king;* and that those princes only assumed this name when they ascended the throne, at which time they also relinquished their former names. Hence it comes to pass, says Josephus, that Herodotus names none of the kings of Egypt after Menes the builder of Memphis, although he had three hundred and thirty successors, because they had all the name of Pharaoh; but because it did not pass to women, he names an Egyptian queen, Nicaule, who succeeded them. Lastly, Josephus concludes, from the ancient records of his nation, that after the age of Solomon no king of Egypt bore any longer the name of Pharaoh.

But Josephus is not accurate in this passage. It is true, Herodotus says that Menes was the first king of Egypt, and the founder of Memphis; that there were three hundred and thirty kings after him in that country; and that after them there was a queen called Nicotris, and not Nicaule, as Josephus writes it. But it is not true that these kings had no other name but that of Pharaoh. Herodotus says expressly, that in the books of the Egyptian priests were inserted the names and the catalogue of three hundred and thirty kings; that in this number of three hundred and thirty there were eighteen Ethiopians, and a woman, who was a foreigner, called Nicotris; and that all the others were Egyptians. These princes therefore had every one his proper name mentioned in the catalogue of the Egyptian kings. Thus, in the fragments of Manetho, we find that every king of Egypt had a name peculiar to himself; whilst the name of Pharaoh occurs only in Scripture. What Josephus adds concerning Queen Nicaule, or Nicotris, whom he pretends to be the same as the queen of Sheba, of whom mention is made in Scripture, is entirely fabulous; and as to his statement, that since the time of Solomon the kings of Egypt have no longer borne the name of Pharaoh, it is manifestly false, since we still find his name in the second book of Kings, under Hezekiah;[1] under Josiah,[2] where this name is joined to that of Nechoh, which was the proper name of the prince; under Jehoiakim;[3] and likewise in the writings of Isaiah, Jeremiah, and Ezekiel, who were much later than Solomon. It is probable, indeed, that the Egyptians gave the name of Pharaoh to their kings as long as the Egyptian language was in common use, and as long as their kings were of their own nation; but after the conquest of Egypt by Alexander the Great, when the Greeks introduced their language and their government, the name of Pharaoh was no longer known amongst them. Indeed it had ceased to be so from the date of the Persian invasion under Cambyses. The first prince known to us by the name of Pharaoh was he in whose time Abraham went down to Egypt, when Sarah, who passed only for Abraham's sister, was by the command of Pharaoh brought to his palace in order to become his wife. But the Lord smote Pharaoh and his family with great infirmities, and gave him to know that she was Abraham's wife; upon which Pharaoh sent for Abraham, restored him his wife, and at the same time gave orders that he should be conducted out of Egypt, with every thing that belonged to him.

Pharaoh.

The second Pharaoh spoken of in the Scripture is he who reigned when Joseph arrived there. This prince or his successor had the mysterious dream of the fat and the lean kine, and the seven full and barren ears of corn, which Joseph explained so much to his satisfaction that he made him governor of his house and of all Egypt, reserving only to himself the name of king. This is the same Pharaoh who sent for and entertained the patriarch Jacob and his family in Egypt, and gave them the land of Goshen for their habitation.

The third Pharaoh mentioned in Holy Writ is he who persecuted the Israelites. Moses tells us that he was a new king, and had no knowledge of Joseph. This prince, observing that the Israelites had become numerous and powerful, resolved to depress them by hardship and labour, and set cruel and pitiless taskmasters over them. But the more he oppressed them the faster they multiplied; insomuch that he gave orders to the Egyptian midwives, who assisted the Hebrew women in their labour, to put all the male children to death, and to save alive the females only. But this command was not strictly executed. The midwives feared the Lord, and preserved alive not only the female children, but also the males. Pharaoh, finding this project did not succeed to his wishes, published a decree that all the male children born of Hebrew women should be thrown into the Nile, and that only the females should be spared. This order was rigorously executed; yet, by the providence of God, Moses was preserved, and even brought up in Pharaoh's court, by his own daughter, who by chance had found the child, as he was exposed amongst the rushes of the Nile.

Moses being grown up, and having killed an Egyptian who had abused an Hebrew, was obliged to fly from Egypt in order to avoid that death which Pharaoh had threatened him withal. But several years afterwards, being about eighty years old, he returned by order from God, and performed mighty miracles before Pharaoh. There is a good deal of probability that this Pharaoh before whom Moses appeared, and in whose sight he smote Egypt with so many plagues, was a different person from him who would have laid hands on the Jewish chief after he had slain the Egyptian. This Pharaoh having been at last compelled to send away the Hebrews, and to suffer them to quit Egypt, soon repented of the leave he had given, and pursued them at the head of his army with his chariots. But he was drowned in the Red Sea, in which he had rashly entered in the eagerness of pursuit. Several historians pretend to give the name of this Pharaoh; some, as Apion, calling him Amosis or Amasis; Eusebius, Chenchris; and Usher, Amenophis; but we may be assured that there is nothing certain in all this.

The fifth Pharaoh known to us is he who afforded protection to Hadad, son of the king of Edom, and who gave him to wife the sister of his own queen, enriched him with lands, and brought up his son Genubah in his own court. Hadad returned to Idumæa after the death of David.

The sixth Pharaoh is he who gave his daughter in marriage to Solomon, king of the Hebrews (1 Kings, iii. 1), and who, having taken Gezer, set it on fire, drove out the Canaanites, and gave it as a present to Solomon, in lieu of a dowry to his daughter, whom he had married to this prince (1 Kings, ix. 16).

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[1] 2 Kings, xviii. 21.

[2] Ibid. xxiii. 29, 33.

[3] Ibid. xxiii. 34, 35.

The seventh is Shishak, who entertained Jeroboam in his dominions, a rebellious subject of Solomon, and offered him a refuge in opposition to the king his master. The same Shishak declared war against Rehoboam the son and successor of Solomon, besieged and took Jerusalem, and carried away all the king's treasures, and those of the house of God, particularly the golden bucklers which Solomon had made.

The eighth is that Pharaoh with whom Hezekiah formed a league against Sennacherib, king of Assyria, in the year of the world 3290. This Pharaoh is probably the same whom Herodotus names Sethon, priest of Phtha, who came to meet Sennacherib before Pelusium, and to whose assistance Phtha sent an army of rats, which gnawed the bowstrings and the thongs of the bucklers of Sennacherib's soldiers.

The ninth is Pharaoh Nechoh, or Nechos, the son of Psammeticus, who made war on Josiah, and conquered him. Herodotus also mentions this prince.

The tenth of this name is Pharaoh Hophrah, who entered into an alliance with Zedekiah, king of Judah, and attempted to march to his assistance against Nebuchadnezzar, king of Chaldæa. It was against this Pharaoh that Ezekiel pronounced several of his prophecies.[1] He is called Apries in Herodotus,[2] and is also mentioned in Habakkuk.[3]

PHARAON, or PHARO, is the name of a game of chance. The principal rules of pharo are as follow: The banker holds a pack consisting of fifty-two cards; he draws all the cards, one after the other, and lays them down alternately at his right hand and his left; then the ponte may at his pleasure set one or more stakes upon one or more cards, either before the banker has begun to draw the cards, or after he has drawn any number of couples. The banker wins the stake of the ponte when the card of the ponte comes out in an odd place on his right hand, but loses as much to the ponte when it comes out in an even place on his left hand. The banker wins half the ponte's stake when it happens to be twice in one couple. When the card of the ponte being but once in the stock happens to be the last, the ponte neither wins nor loses; and the card of the ponte being but twice in the stock, and the last couple containing his card twice, he then loses his whole stake. Demoivre has shown how to find the gain of the banker in any circumstance of cards remaining in the stock, and of the number of times that the ponte's card is contained in it. Of this problem he enumerates four cases, viz. when the ponte's card is once, twice, three, or four times in the stock. In the first case, the gain of the banker is $\frac{1}{n}$, n being the number of cards in the stock. In the second case, his gain is $\frac{\overline{n-2}\times y}{n\times\overline{n-1}}+\frac{2}{n\times\overline{n-1}}$, or $\frac{\frac{1}{2}n+1}{n\times\overline{n-1}}$, supposing $y=\frac{1}{2}$. In the third case, his gain is $\frac{3y}{2\times\overline{n-1}}$, or $\frac{3}{n\times\overline{n-1}}$, supposing $y=\frac{1}{2}$. In the fourth case, the gain of the banker, or the loss of the ponte, is $\frac{2n-5}{\overline{n-1}\times\overline{n-3}}\,y$, or $\frac{2n-5}{2\times\overline{n-1}\times\overline{n-3}}$, supposing $y=\frac{1}{2}$. Demoivre has calculated a table, exhibiting the gain or loss in any particular circumstance of the play; and he observes, that at this play the least disadvantage of the ponte, under the same circumstances of cards remaining in the stock, is when the card of the ponte is but twice in it, the next greater when three times, the next when once, and the greatest when four times. He has also demonstrated, that the whole gain per cent. of the banker, upon all the money that is adventured at this game, is L.2. 19s. 10d. (See Demoivre's *Doctrine of Chances.*)

PHARISEES, a famous sect amongst the Jews, who distinguished themselves by their zeal for the traditions of the elders, which they derived from the same fountain with the written word itself; pretending that both were delivered to Moses from Mount Sinai, and were therefore of equal authority. From their rigorous observance of these traditions, they looked upon themselves as more holy than other men; and therefore separated themselves from those whom they thought sinners or profane, so as not to eat or to drink with them. Hence, from the Hebrew word *pharic*, which signifies to separate, they received the name of *Pharisees* or *Separatists*.

This sect was one of the most ancient and considerable amongst the Jews; but its origin is not very well known. However, it was in great repute in the time of our Saviour, and must have had its origin at the same time with the traditions; in fact, they grew together, until at length they had so far gained ground that the traditional law swallowed up the written, and those who were the propagators of it included the bulk of the Jewish nation.

The extraordinary pretences of the Pharisees to righteousness drew after them the common people, who held them in the highest esteem and veneration. Our Saviour, however, frequently charges them with hypocrisy, and with making the law of God of no effect through their traditions.[4] Several of these traditions are particularly mentioned in the gospel; but they had a vast number more, which may be seen in the Talmud, the grand object of which is to explain and enforce those which this sect required to be believed and observed.

The Pharisees, contrary to the opinion of the Sadducees, held a resurrection of the dead, and the existence of angels and spirits. But, according to Josephus, this resurrection of theirs was no more than a Pythagorean resurrection, that is, of the soul only, by its transmigration into another body, and being born anew with it; and from this they excluded all who were notoriously wicked, being of opinion that the souls of such persons were consigned to a state of everlasting wo. As to lesser crimes, they held that these were punished in the bodies which the souls of those who committed them were next sent into.

Josephus, however, either mistook the faith of his countrymen, or, which is equally probable, wilfully misrepresented it, in order to render their opinions more respected by the Roman philosophers, whom he appears on every occasion to have been desirous to please. The Pharisees had many pagan notions respecting the soul; but Bishop Bull, in his *Harmonia Apostolica*, has clearly proved that they held a resurrection of the body, and supposed a certain bone to remain uncorrupted in order to furnish the matter out of which the resurrection of the body was to be effected. They did not, however, believe that all mankind were to be raised from the dead. A resurrection was the privilege of the children of Abraham alone, who were all to rise on Mount Zion; their incorruptible bones, wherever they might be buried, being carried to that mountain below the surface of the earth. The state of future felicity, in which the Pharisees believed, was in fact exceedingly gross. They imagined, that men in the next world, as well as in the present, were to eat and drink, and enjoy the pleasures of love, each being reunited to his former wife. Hence the Sadducee, who believed in no resurrection, and supposed that our Saviour taught it as a Pharisee, shrewdly urged

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[1] Ezekiel, xxix. xxx. xxxi. xxxii.

[2] Herodotus, lib. ii. c. 161.

[3] Habakkuk, ii. 15, 16.

[4] Matth. ix. 2, xv. 1-6, xxiii. 13-23; and Luke, xi. 39-52.

Pharos
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Pherecrates.

the difficulty of disposing of the woman who had in this world been the wife of seven husbands. Had the resurrection of Christianity been of the Pharisaical kind, this difficulty would have been insurmountable; and accordingly we find the people, and even some of the Pharisees themselves, struck with the manner in which our Saviour removed it.

This sect appears to have had some confused notions, derived probably from the Chaldæans and Persians, respecting the pre-existence of souls; and hence it was that Christ's disciples asked him, concerning the blind man, "Who did sin, this man or his parents, that he was born blind?" And when the disciples told Christ, that some said he was Elias, Jeremias, or one of the prophets, the meaning of this can only be, that they thought he had come into the world with the soul of Elias, Jeremias, or some other of the old prophets, transmigrated into him. Like the Essenes, the Pharisees held absolute predestination, and like the Sadducees, free-will; but how they reconciled these incompatible doctrines is nowhere sufficiently explained. The sect of the Pharisees was not extinguished by the ruin of the Jewish commonwealth. The greater part of the modern Jews are still of this sect, and as much devoted to traditions or the oral law as their ancestors ever were.

PHARMACI were two persons employed in the lustration or purification of cities. Some say that they were both men; but others maintain, that a man to represent the males, and a woman to represent the females, performed this office. They offered sacrifice, and wore figs about their necks; those of the men being blackish, and those of the women white. Figs were an emblem of fertility, which they doubtless prayed for on these solemn occasions.

PHARMACEUTICAL, any thing connected with pharmacy, or the processes employed in the preparation of medicines.

PHARMACOCHEMIA, an obsolete term, denoting that part of the chemical art which treats of the preparation of medicines, and used in contradistinction to that of chemistry, which was wholly employed about the transmutation of metals by means of the philosopher's stone, and hence called *spagirico-chemia*.

PHARMACOPŒIA (from φαρμακον, *remedy*, and ποιειν, *to make*), means a dispensatory, or a treatise describing the preparations of the several kinds of medicines, with their uses, modes of application, and so forth.

PHARMACOPOLA, or PHARMACOPEIUS, an apothecary, or a person who prepares and sells medicines. This word, which is rarely used except in the way of ridicule, is composed of φαρμακον, *medicine*, and πολειν, to *sell*.

PHARMACUM, φαρμακον, a medicine or medicament, either of a salutary or deleterious quality.

PHARMACY, the art of preparing, preserving, and compounding medicines. See MATERIA MEDICA, and THERAPEUTICS.

PHAROS, a small oblong island, adjoining the continent of Egypt, and over-against Alexandria. On this island stood a lighthouse of the same name, having four sides, each a stadium in length, and a tower so elevated as to be seen nearly a hundred miles off. Some affirm that each of its four corners rested on a large sea-crab of hard transparent stone brought from Ethiopia or Memphis; but others imagine that the crabs were only added externally to the base by way of ornament, or as emblematical of its situation and use. The architect was Sostrates the Cnidian, as appears by an inscription engraved upon the tower, under Ptolemy Philadelphus, who expended upon it eight hundred talents. On account of the port of Alexandria, the entrance to which was difficult and dangerous, the Pharos was called "the key of the Egyptian Sea," and even of Egypt itself; and Pharos, from being originally a proper name, at length became an appellative to denote all kinds of lighthouses.

PHAROS, a lighthouse or pile of building, raised near a port, where fire is kept burning in the night, to guide and direct vessels near at hand. The pharos of Alexandria, built on the island of Pharos, was anciently so famous that it communicated its name to all the rest. This magnificent tower consisted of several stories and galleries, with a lantern at the top, in which a light being kept continually burning, might be seen many leagues at sea, and along the coast. It was accounted one of the seven wonders of the world. It was built by the celebrated architect Sostrates, a native of Cnidus, or, according to some, by Deiphanes, the father of Sostrates, and cost Ptolemy Philadelphus eight hundred talents. See SEA-LIGHTS.

PHARSALIA, in *Ancient Geography*, a town of the Phthiotes, a district of Thessaly, near Pheræ and Larissa. To this last place Pompey fled from the plains of Pharsalus; it is watered by the river Enipeus, which falls into the Apidamus, and both together unite with the Peneus. Between Pharsalia and Enipeus Pompey drew up his men at the decisive battle of Pharsalia. See ROME.

PHASES, in *Astronomy*, a word formed from the Greek verb φαινω, *to appear*, are the several appearances or quantities of illumination of the moon, Venus, Mercury, and the other planets. See ASTRONOMY.

PHEBE, a deaconess of the port of Corinth, called Cenchrea. St Paul had a particular esteem for this holy woman; and Theodoret thinks the apostle lodged for some time at her house, whilst he continued at or near Corinth. It is thought that she brought to Rome the epistle he addressed to the Romans, in which she is recommended in so advantageous a manner. The apostle says (Rom. xvi. 1, 2), "I commend unto you Phebe our sister, who is a servant of the church which is at Cenchrea, that ye receive her in the Lord, as becometh saints, and that ye assist her in whatsoever business she hath need of you; for she hath been a succourer of many, and of myself also." Some moderns have advanced a notion that Phebe was the wife of St Paul; but none of the ancients has said any thing to justify such an opinion. It is generally supposed that, in quality of deaconess, she was employed by the church in some ministrations suitable to her sex and condition; as to visit and instruct the Christian women, to attend them in their sickness, and to distribute alms amongst them.

PHEGOR, or PEOR, a deity worshipped at a very early period by the Midianites and Moabites, and probably by all the other tribes who then inhabited Syria. Much has been said concerning the functions of this god, and the rank which he held amongst the Pagan divinities; and many conjectures have been formed concerning the origin of his name. But most of these appear to have no better foundation than the senseless dreams of the Jewish rabbin. *Phegor*, or *Peor*, is undoubtedly the same with the Hebrew word *pechor*, which signifies "aperuit," and probably refers to the prophetic influence always attributed to the solar deity, by which he *opened* or *discovered* things to come. Accordingly we find Phegor or Peor generally joined to *Baal* or *Bel*, which was the Syrian and Chaldæan name of the sun after he became an object of worship; and hence *Bel-phegor* must have been the sun worshipped by some particular rites, or under some particular character.

PHENGITES, amongst the ancients, the name of a beautiful species of alabaster. It is a rude irregular mass, very brittle and friable, but of a brightness superior to that of most other marbles, and excelling them all in transparency.

PHEONS, in *Heraldry*, the barbed heads of darts, arrows, or other weapons.

PHERECRATES, a writer of the ancient comedy, was a native of Athens, and contemporary of Plato, Aristophanes, Phrynichus, and Eupolis. According to Suidas, he was a soldier in his youth, but afterwards attached himself to the stage, and became one of the most successful dramatic writers. We know that he exhibited a play entitled Savages ('Αγριοι), B. C. 420 (Plato, Protag. 327, d; Athen. v. 218, d). He invented a species of verse, called from his name Pherecratian, consisting of a spondee, and the two last feet of an hexameter line. Suidas attributes seventeen plays to him, referring probably to those only which he considered as genuine, since the titles of twenty are found in Athenæus. The fragments of Pherecrates have been collected by Hertel in *Vetustissimorum Comicorum Sententiæ*, p. 340–57. Of all the fragments of Pherecrates, the most remarkable is that entitled Cheiron, in which he introduces music, clad in rags, to which state she says she has been reduced by Melanippides, Phryoris, and Timotheus, the authors of some innovations on that art. (See *Mém. de l'Acad. des Inscript.* xv. 330.)

PHERECYDES, a Greek philosopher of the island of Syros, one of the Cyclades, was the son of Badys, and the pupil of the celebrated Pittacus of Mitylene. The exact date of his birth and death is unknown, but he flourished B. C. 544, being a contemporary of Thales, Anaximenes, Anacreon, and Hipponax. There is some doubt whether he is not the astronomer Pherecydes who constructed a sun-dial at Syros; but as this person is said to have been the master of Thales, it is more likely that there was another of an earlier date. The philosopher was the instructor of Pythagoras, and is said to have foretold earthquakes by observing the movement of water in wells (Cic. *Tus.* i. 16; *Div.* i. 50). There were various accounts respecting his death, but most are agreed that he was devoured by worms and insects like Sylla; and the reason assigned was, that he had offended Apollo, because he said that he lived very happily though he had never sacrificed to the gods. (Ælian. *V. H.* iv. 28.) Pherecydes was the author of a work on Nature and on the Gods, being the first of the Greeks who wrote on this subject. (Diogenes Laertius, *Life of Pherecydes.*) The fragments of Pherecydes have been collected by Auguste Wolf, in the first part of his *Litterarische Analecten*, Berlin, 1817.

PHERECYDES, an historian of the island of Leros, in the Ægean Sea, is satisfactorily proved by Vossius (*De Hist. Græcis*, p. 444) to be the same who is called an Athenian by some. He flourished B. C. 480, in the reign of Darius Hystaspes, and preceded Herodotus by a few years. He is said to have made a collection of the poems of Orpheus, to have written on the genealogy of the gods (*Theogoneia*) in ten books, on the mythological part of the history of Athens ('Αυτόχθονας) in ten books, and moral maxims in hexameter verse. The fragments of Pherecydes, along with those of Acusilaüs, have been published by Sturz, Gera, 1789, 1798, with a learned dissertation.

PHIDIAS, a celebrated Greek statuary, was the son of Charmidas, a native of Athens, and flourished B. C. 444, in the age of Pericles, being the contemporary of Alcamenes, Critias, Hegias, and Nestocles. In his representations of the gods he was so successful that it was said he must either have visited heaven, or the gods must have descended to him. (Analect. Brunck. vol. ii. p. 225.) One of the finest of his works was his statue of Jupiter Olympius, in the temple of Olympia. It was made of ivory and gold, and was of such colossal size, that being seated, it appeared, that if it rose up, it could carry away the roof. Being asked by his brother Panænus what model he had followed in his representation of the god, Phidias referred him to the portrait of Jupiter given by Homer (*Iliad.* i. 528–530). His statue of Minerva at Athens was also very much admired, and the shield of the goddess presented a fine specimen of bas-relief. Along the edge was sculptured the battle of the Amazons, and in the hollow part the battle of the gods and giants. (Strab. viii. 353; Plin. xxxvi. 4, 7; Paus. v. 10, 2; Quint. xii. 10, 1; Val. Max. iii. 7, 4. In the time of Pliny, there was a Venus by him, in the portico of Octavia; and at present there is a magnificent colossal statue of a man curbing a fiery steed, placed before the palace of the Vatican at Rome, which is inscribed with the name of Phidias, but the group has no right to be considered as his production. Phidias was the teacher of Alcamenes, Agoracritus, and Colotes. (Plin. xxxiv. 19, 1–5, xxxv. 34, 1.)

PHIDITIA, in Grecian antiquity, feasts celebrated with great frugality at Sparta. They were held in the public places and in the open air. Rich and poor assisted at them equally, and upon the same footing; their design being to keep up peace, friendship, good understanding, and equality amongst the citizens, great and small. It is said that those who attended this feast brought each a bushel of flour, eight measures of wine, five pounds of cheese, and two pounds and a half of figs, with some money.

PHILA, in *Mythology*, one of the attributes of Venus, which distinguished her as the mother of love; from φιλειν, *to love.*

PHILADELPHIA, in *Antiquity*, were games instituted at Sardis to celebrate the union of Caracalla and Geta, the sons of Septimius Severus.

PHILADELPHIA, the second city in size and importance in the United States of North America, and the commercial metropolis of Pennsylvania. It is situated on the west bank of the Delaware, five miles from its junction with the Schuylkill, and extending from the one river to the other. From the city to the estuary of the Delaware, the distance is a hundred and twenty-six miles, including the bendings of the river; but the stream is so broad and deep at Philadelphia as to afford sufficient water for vessels of any size except those of the first class. Originally it formed a parallelogram, extending west about two miles from the Delaware, beyond the Schyulkill, and north and south a little more than a mile. As commerce increased, Philadelphia of course was enlarged, the buildings naturally extending along the Delaware, and now forms an oblong square reaching from the lower part of Southwark to the upper part of Kensington, nearly four miles, and, as we have said, from the one river to the other. It is noted for the regularity with which it is laid out. The main streets, twenty-five in number, and running from north to south, are intersected at right angles by others stretching east and west. There is an immense number of squares, it is supposed above three hundred and fifty. Some of the streets are a hundred feet and upwards in breadth; they are all well paved, and kept remarkably clean, being mostly furnished with common sewers. The houses altogether exhibit an appearance of neatness, uniformity, and commodiousness, and most of them are ornamented with white marble steps and window-sills. The most conspicuous buildings are some of the churches, the state-house, the United States and Pennsylvania banks, the institution for the deaf and dumb, and the Pennsylvania hospital. There are above a hundred places of public worship, but, with the exception of the first Presbyterian church, and two or three Episcopalian chapels, which are noble edifices, they are neither remarkable for their architecture nor their size. The front of Pennsylvania hospital is two hundred and seventy-three feet in breadth; and in connection with it there is a building sufficiently large to contain above fifty patients. There are a number of other institutions for the sick and the destitute, the buildings of which, together with the former, occupy an entire square, in the centre of which is a leaden statue of the founder of the city. The building for the reception of the deaf and dumb was erected in 1824, and is constructed of granite. It is of considerable size, and, having received handsome dona-

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tions from various quarters, the managers of the institution are enabled to receive pupils from other states besides that in which it is situated. The object of this school is to give a common education to the deaf and dumb, and to train them to industrious habits, the course of instruction varying from four to six years.

The bank of the United States was established in the year 1816, with a capital of thirty-five millions of dollars. The banking-house is a splendid structure, built on the plan of the Parthenon at Athens, and is considered as the most finished specimen of pure Grecian architecture in America. It is constructed of white marble, having in front eight fluted Doric columns, four feet and a half in diameter. On each of the fronts is a portico projecting ten feet and a half. The whole length of the edifice, including the portico, is a hundred and sixty-one feet; its breadth being eighty-seven feet. The banking-room, which occupies the centre of the building, is eighty-one feet in length by forty-eight feet in breadth. The whole immense structure is arched, and rendered bomb-proof from the cellar to the roof, which is covered with copper. The bank of Pennsylvania is likewise a fine specimen of classical architecture, and built of the same material as the former. The state-house is a large brick building, comprising a centre and two wings, and presenting altogether a venerable appearance, never having been altered since its first erection. In the eyes of the Americans it will remain a feature of great interest as long as it lasts; for it was here the continental congress held its meetings, and from it the declaration of independence was first promulgated. There are several theatres, which are esteemed highly respectable buildings. The masonic hall, built in the Gothic style, is a large edifice, but more remarkable for its size than for its architectural beauty. The arcade is an imposing stone structure, containing the best museum in America; and the academy of arts is likewise a respectable edifice, enriched internally with a large number of paintings and some very fine statues. The university of Pennsylvania is distinguished by the celebrity of the medical school attached to it. The new halls, which were erected in the year 1830, are spacious, and built in a handsome style of architecture. The number of medical students who attend it vary from 400 to 500 annually. The hall of the Jefferson medical college is also a spacious building. There are three prisons in Philadelphia, one of which is built in the style of the castles of the middle ages, and is considered as a great ornament to the city. It is called the New Penitentiary, and occupies ten acres of ground, being designed to carry the principle of solitary confinement completely into effect.

The United States mint was established in Philadelphia in the year 1791, and by several successive acts of congress has been continued in the same place ever since. The old buildings, however, have been supplanted by a spacious new edifice, which was commenced in 1829. This splendid structure is faced with marble, and presents a front of a hundred and twenty-two feet, divided into a portico sixty-two feet long, and two wings each of thirty feet in length. The building is of the Ionic order, taken from the celebrated Grecian temple on the river Illisus, near Athens. The total value of the gold, silver, and copper coinage struck at this mint during the year ending January 1837 was 7,764,900 dollars. The report for that year states that great and important improvements had been introduced into every department of the mint. Changes have been made in the arrangements for assaying, which place this part of the establishment upon a footing with the most perfect in Europe. The marine asylum stands on the eastern bank of the Schuylkill, a short distance south of the city line. It is three hundred and eighty-six feet in length, consisting of a portico of ninety feet, supported by eight Ionic columns, and two wings, each a hundred and forty-eight feet in extent. But of all the public works of Philadelphia there are none of which its inhabitants are so justly proud as those at Fair Mount, by which the city is supplied with water of the best quality, and in the greatest abundance. Nothing of the kind has been executed on the American side of the Atlantic that will bear any comparison with the arduous and expensive operation of introducing the Schuylkill water. At two different times plans were adopted for the purpose of supplying Philadelphia with water; but both having proved inefficient, the present magnificent undertaking was commenced in 1819, and completed at an expense of about one million and a half of dollars. Fair Mount is in the rear of the city, upon the bank of the Schuylkill, the neighbourhood of which presents some remarkably beautiful and romantic scenery. The reservoirs are situated on the top of a hill rising from the river, a part of it perpendicular rock, to the height of a hundred feet. They are calculated to contain thirty millions of gallons of water, which is sufficient to supply the city for ten days. It was formerly forced into the reservoirs by means of steam, which is no longer used; it is now raised by machinery propelled by the river. There are five large water-wheels turned, one of which, made of iron, weighs twenty-four tons. If all are put in motion at once, they will raise seven millions of gallons in twenty-four hours, which is more than double the quantity required even in summer. To turn them, the Schuylkill has been dammed in its whole breadth, by which the water is thrown back into a reservoir lock, whence it is admitted as required to operate upon the wheels, and is discharged into the river below the dam. The iron pipes through which the water is conveyed to the city and districts are about sixty miles in extent. The water thus circulated so abundantly through the city is of immense service in cases of fire, as it is only necessary to screw the hose to hydrants, which are placed at convenient distances, to secure a constant stream of sufficient force to reach any ordinary height. There are sixteen hose companies, and about thirty engine companies; in short, the arrangements made in Philadelphia for the speedy extinction of conflagrations are of the first order.

The city library is indebted for its origin to Benjamin Franklin. It was commenced as early as 1731, and incorporated eleven years afterwards. In 1790 the present neat and ornamental edifice was erected opposite to the state-house square; and over the front door is placed a fine marble statue of its founder. In 1837 it contained 44,000 volumes. There are other institutions of the kind, which contain upwards of ten thousand volumes. Opposite the Philadelphia library is the Athenæum, a valuable institution, established in 1814. Attached to it is a library, and a spacious reading-room, well supplied with newspapers from Europe and other quarters of the world, besides nearly a hundred from various parts of the United States. The university of Philadelphia was founded in the year 1755, and is one of the most respectable and flourishing institutions of the kind in the union. Academies and other seminaries of education are numerous, and efficiently conducted. The city and county of Philadelphia constitute a school district, under special regulations. By the report for the year 1837, it appears that the schools in it were attended by above eleven thousand children; and from the same document we learn that the arrangements for the general diffusion of instruction are very extensive and highly efficient. There are in this city a number of benevolent societies, various institutions which have for their object the relief of the sick, the helpless, the destitute, and other objects of compassion. In this respect it is upon a level with any city of the same size in Europe.

The harbour of Philadelphia, from the peculiar nature of the Delaware River, is more liable to be impeded by ice

Philadelphia. than those of New York and Baltimore; but otherwise it possesses perhaps as many natural advantages as either of them. Its trade is very great, as will be seen in the article Pennsylvania. The navy-yard situated on the Delaware is of great extent, and fitted up with first-rate appurtenances for building frigates and ships of the line. Shipbuilding is briskly carried on; and this city has also a high reputation for the extent and excellence of its breweries. It is, besides, famous for its manufactures, paper-making, printing, and publishing establishments, and its periodicals and journals of every description.

Philadelphia was founded by William Penn in the year 1682. On the 5th of September 1774 the members of the first congress assembled here, and adopted that celebrated declaration of rights, the preface to the declaration of independence which was promulgated from the state-house about two years afterwards. Congress continued to sit in this city until the approach of the royalists in September 1777, when it fell into their hands, and was retained by them until June following. During the remainder of the war it happily escaped the ravages of hostile operations. It was also the seat of the state government until the year 1800. For municipal purposes the legislature has from time to time established corporate governments in different parts of the suburbs, so that Philadelphia is now divided into several districts. The municipal government of the city proper is vested in a mayor, a recorder, fifteen aldermen, and a select and common council, besides subordinate executive officers. The recorder and aldermen are appointed by the governor of the state; and the mayor is chosen by the councils, from the body of the citizens. The members of the select and common council are annually elected by the people. They receive no compensation, sit in separate chambers, and each body has a negative on the legislative acts of the other. The city proper sends seven representatives and two senators to the state legislature. The population of Philadelphia, according to the census of 1810, was 96,664, in 1820 it was 119,325, in 1830 it was 167,811, and at present (1838) it is estimated at about 200,000 souls.

Philadelphia, the name of an ancient town of Turkey, in Asia Minor, or Natolia, founded by Attalus Philadelphus, brother of Eumenes. In the year 1097 it was taken by John Ducas, the Greek general; and, in the year 1106, it was, without difficulty, reduced by the same individual. The Turks marched from the East with a design to plunder this and the maritime towns; and, in 1175, the Emperor Manuel retired thither for protection against these invaders. In 1300, it fell by lot to Karaman. In 1306, it was besieged by Alifaras, and considerably harassed, but not taken. In 1391, Philadelphia alone refused to admit Bajazet; but it was at length forced to capitulate, from want of provisions. It has been matter of surprise that this town was not totally abandoned; and yet it has survived many cities less liable to inconveniences, and is still an extensive place, though in its appearance it is poor and mean. Some remnants of its walls are still standing.

Philadelphian *Society*, in *Ecclesiastical History*, was an obscure and inconsiderable society of mystics. They were formed about the end of the seventeenth century by an English female fanatic, whose name was Jane Leadley. This woman seduced, by her visions, predictions, and doctrines, several disciples, amongst whom were some persons of learning. She believed that all dissensions amongst Christians would cease, and that the kingdom of the Redeemer would become a scene of charity and felicity, if Christians, disregarding the forms of doctrine or discipline in their several communions, would all join in committing their souls to the care of the internal guide, to be instructed, governed, and formed by his divine impulse and suggestions. She even went farther than this, pretending a divine commission to proclaim the approach of the communion of saints; and declaring that the society established by herself was the true kingdom of Christ. One of her leading doctrines was that of the final restoration of all intelligent beings to perfection and happiness.

PHILADELPHUS, in *Antiquity*, was a title or surname borne by several ancient kings, being formed from the Greek φιλος, *friend*, and ἀδελφος, *brother*; that is, one who loves his brother or brethren.

PHILÆNI, were two brothers, citizens of Carthage, who sacrificed their lives for the benefit of their country. At the time when the Carthaginians ruled over the greater part of Africa, the Cyrenians were also a great and wealthy people. The intervening country being all sandy, and of an uniform appearance, there was neither river nor mountain to distinguish their limits; a circumstance which involved them in frequent disputes and contentions. After their armies and fleets had often been routed and put to flight on both sides, and they had weakened one another greatly, fearing lest, by and by, some third people should fall upon the conquered and the conquerors, both parties agreed to a cessation of arms, which was followed by an engagement, "that upon a day appointed deputies should set out from their respective homes, and the place where they met one another should be accounted the common boundary of both nations." Accordingly, the two brothers called Philæni, when sent from Carthage, made all despatch to perform their journey. The Cyrenians, who proceeded more slowly, found themselves somewhat late; and becoming apprehensive of punishment for mismanaging the affair, charged the Carthaginians with setting out before the appointed time, and made a mighty bustle about it, being resolved not to be overreached. But as the Carthaginians declared their willingness to accept any other terms, provided only these were fair, the Cyrenians made this proposal to the Carthaginians, viz. either to be buried alive in the place which they claimed as the boundary to their nation, or to advance forward to whatever place they inclined upon the same condition. The Philæni accepted the offer, and, sacrificing themselves to their country, were actually buried alive. In the spot where they were interred the Carthaginians dedicated to the memory of the two brothers altars, which, being called *Aræ Philænorum*, served as a boundary to the empire of the Carthaginians, which now extended from this monument to the Pillars of Hercules, or, according to the observations of the moderns, about 1420 geographical miles. Sallust, in his history of the Jugurthan war, records the singular circumstance here related.

PHILANTHROPY is compounded of two Greek words signifying the love of mankind. It is therefore of nearly the same import with *benevolence*, and differs from *friendship*, as the latter affection subsists only between a few individuals, whereas philanthropy comprehends the whole human race.

Whether man has an instinctive propensity to love his species, which makes him incapable of happiness except in the midst of society, and impels him to do all the good that he can to others, feeling their felicity an addition to his own, is a question which has been warmly debated amongst philosophers ever since metaphysics was studied as a science. See Metaphysics and Moral Philosophy.

PHILEMON, a writer of the new comedy, was born at Soli, in Cilicia, but the precise date of his birth and death is unknown. He began to exhibit his plays at Athens in the reign of Alexander, B. C. 336–323, and died in the reign of the second Antigonus, son of Demetrius, probably about B. C. 280, at the age of ninety-six. He was the contemporary of Menander, and frequently carried off the prize from him, by the attention he paid to humour the prejudices of the people. He was the author of ninety comedies, the names of fifty-one of which are given by Fabricius in his *Bibliotheca Græca*, having been collected from Athenæus, Pollux, and other ancient authors. Plautus imitated Philemon in his comedy of the Merchant, and in that of the Bacchides. The fragments of Philemon have been collected by Hertel and Gronovius. They have also been published along with the fragments of Menander, Amsterdam, 1709, 8vo. (See MENANDER.)

PHILETAS, a Greek poet and grammarian, belonging to the island of Cos, flourished under Philip and Alexander the Great, and was preceptor of Ptolemy Philadelphus. He was the author of some Elegies, Epigrams, and other works, which have not come down to us, and is celebrated in the poems of Ovid and Propertius as one of the best poets of his age. Ælian informs us, we presume in jest, that his body was so slender and feeble, that he was obliged to have some lead in his pockets, to prevent his being carried away by the wind.

PHILIBEG, called also a *kilt*, is a sort of short petticoat reaching nearly to the knees, which is worn by the Scotch Highlanders. It is a modern substitute for the lower part of the plaid, being found to be less cumbersome, especially in time of action, when the Highlanders used to tuck the brechtan into their girdle.

PHILIP, one of the apostles, was a native of Bethsaida in Galilee. Jesus Christ having seen him, said to him, "Follow me." Philip obeyed, and soon afterwards finding Nathaniel, said to him, "We have found the Messiah, of whom Moses and the prophets have spoken, Jesus of Nazareth, the son of Joseph." Nathaniel, however, true to the prejudices of his time, asked him, "Can any thing good come out of Nazareth?" To this Philip replied, "Come and see." He then brought Nathaniel to Jesus, and they went with him to the marriage at Cana in Galilee. Philip was called at the very beginning of our Saviour's mission; and when Jesus Christ was about to feed the five thousand who followed him to the wilderness, he asked Philip, in order to prove him, whence bread might be bought for such a multitude of people? Philip answered, that two hundred pennyworth of bread would not be sufficient for every one to taste a little. Some Gentiles, having a curiosity to see Jesus Christ, a little before his passion, addressed themselves to Philip, who mentioned it to Andrew, and both of them to Christ. At the last supper, Philip besought our Saviour that he would be pleased to show them the Father, being all that they desired. But Jesus told them, that, seeing the Son, they saw the Father also. This is all we learn in the gospel concerning Philip.

Upper Asia fell to the lot of this apostle, who took great pains in planting the gospel there, and by his preaching and miracles made many converts. In the latter part of his life he went to Hierapolis in Phrygia, a city much addicted to idolatry, and particularly to the worship of a serpent of a prodigious size. Philip, by his prayers, procured the death, or at least the disappearance, of this monster, and convinced its worshippers of the absurdity of paying divine honours to such odious creatures. But the magistrates, enraged at his success, imprisoned him, and ordered him to be severely scourged, and then put to death, which some say was done by crucifixion, and others by hanging him up against a pillar. Philip is generally reckoned amongst the married apostles; and it is said he had three daughters, two of whom preserved their virginity, and died at Hierapolis, whilst the third, having led a very spiritual life, died at Ephesus. He left no writings behind him, the gospel under his name having been forged by the Gnostics, to countenance their evil principles and worse practices. The Christian church observes the festival of this saint, together with that of St James, on the first day of May.

PHILIP, the name of several kings of Macedonia, the most celebrated of whom was Philip II., father of Alexander the Great. See GREECE and MACEDONIA.

PHILIP. Both France and Spain have likewise had several sovereigns distinguished by this name. See FRANCE and SPAIN.

PHILIP II. son of the Emperor Charles V. and of Isabella of Portugal, was born at Valladolid on the 21st of May 1527, and became king of Naples and Sicily on his father's abdication in 1554. The reign of this prince touches the contemporary history of Europe at so many important points, that a brief notice of it will not perhaps be thought superfluous. He ascended the throne of Spain on the 17th of January 1556. Charles had made a truce with the French, but his son broke it, and having formed an alliance with England, poured into Picardy an army of forty thousand men. The French were cut to pieces at the battle of St Quintin, which was fought on the 20th of August 1557; that town was taken by assault, and the day on which the breach was stormed, Philip appeared armed cap-à-pied, in order to animate the soldiers. It was the first and last time that he was observed to wear the military dress. It is well known, indeed, that during the heat of the action his terror was so great that he made two vows; one, that he should never again be present in a battle; and the other, that he would build a magnificent monastery, dedicated to St Lawrence, to whom he attributed the success of his arms. After the engagement, the Duke of Savoy, who commanded, attempted to kiss his hand; but Philip prevented him, saying, "It is rather my duty to kiss yours, who have the merit of so glorious a victory;" and immediately presented him with the colours taken during the action. The taking of Catelet, Ham, and Noyon, were the only advantages derived from a victory which might have proved the ruin of France. When Charles V. was informed of this success, it is said he asked the person who brought him the intelligence, if his son was at Paris; and being answered in the negative, he went away without uttering a single word. The Duke of Guise having had time to assemble an army, repaired the disgrace of his country by the taking of Calais and Thionville. But whilst the duke was animating the French, Philip defeated Marshal de Thermes in a combat near Gravelines. His army was, on this occasion, commanded by Count Egmont, whom he afterwards caused to be beheaded. The conqueror made no better use of the victory of Gravelines than he had done of that of St Quintin; but he reaped considerable advantage from the glorious peace of Chateau-Cambresis, the masterpiece of his politics. By that treaty, which was concluded on the 13th of April 1559, he gained possession of the strong places of Thionville, Marienbourg, Montmedi, Hesdin, and the county of Charollois. This war, so terrible in itself, and attended with so much cruelty, was, like many others, terminated by a marriage. Philip took for his third wife Elizabeth, daughter of Henry II. who had been promised to his son Don Carlos.

After these glorious achievements, Philip returned in triumph to Spain without having drawn a sword. His first care, upon his arrival at Valladolid, was to demand of the grand inquisitor the spectacle of an *auto-da-fé*. This was immediately granted him, and forty wretches, some of them priests and monks, were strangled and burned. Don Carlos de Seza, one of these unfortunate victims, ventured to draw near to the king, and said to him, "How, Sir, can you suffer so many wretches to be committed to the flames? Can you be witness of such barbarity without weeping?" To this Philip coolly replied, "If my own son were suspected of heresy, I would myself give him up to the severity of the Inquisition. Such is the horror which I feel when I think of you and your companions, that if an executioner were wanting, I would myself supply his place." On other occasions he conducted himself agreeably to the spirit which had dictated this answer.

Philip.

In a valley of Piedmont, bordering on the country of the Milanese, there were some heretics, the followers of Peter Valdo; and these the governor of Milan was commanded to put to death by the gibbet. The new opinions having found their way into some of the districts of Calabria; Philip gave orders that the innovators should be put to the sword.

This spirit of cruelty, and shameful abuse of power, had the effect of weakening that power itself. The Flemings, no longer able to endure so hard a yoke, revolted. The revolution began in the fine and large provinces of the Continent; but the maritime provinces alone obtained their liberty. In 1579 they formed themselves into a republic, under the title of the United Provinces. Philip sent the Duke of Alva to reduce them; but the cruelty of that general only served to exasperate the spirit of the rebels. Never did men fight with more courage or greater fury. The Spaniards, at the siege of Haerlem, having thrown into the town the head of a Dutch officer who had been killed in a skirmish, the inhabitants threw back to them the heads of eleven Spaniards, with this inscription: "Ten heads for the payment of the tenth penny, and the eleventh for interest." Haerlem having surrendered at discretion, the conquerors caused all the magistrates, pastors, and above 1500 citizens, to be hanged.

The Duke of Alva being at length recalled, the grand commander of the Requesnes was sent in his place, and after his death Don John of Austria; but neither of these generals could restore tranquillity in the Low Countries. To the latter succeeded a grandson of Charles V., Alexander Farnese, duke of Parma, the greatest commander of his time; but he could neither prevent the independence of the United Provinces, nor check the advancement of that republic which arose under his very eye. It was then that Philip, always at his ease in Spain, instead of coming to reduce the rebels in Flanders, proscribed the Prince of Orange, and set 25,000 crowns upon his head. But William, superior to Philip, disdained having recourse to any similar proceeding, and trusted to his sword for his preservation. In the mean time the king of Spain succeeded to the crown of Portugal, to which he had a right by his mother Isabella. This kingdom had been subdued by the Duke of Alva in the space of three weeks, during the year 1580. Antony, prior of Crato, having been proclaimed king by the populace of Lisbon, had the resolution to come to an engagement; but he was vanquished, pursued, and obliged to fly for his life.

A cowardly assassin, Balthazar Gerard, killed the Prince of Orange by a pistol-shot, and thereby delivered Philip from his most implacable enemy. Philip was charged with this crime, but it is believed without reason; although, when the tidings were communicated to him, he was imprudent enough to exclaim, "If this blow had been given two years ago, the Catholic religion and I would have gained a great deal by it." This murder had not the effect of restoring to Philip the Seven United Provinces; and that republic, already powerful by sea, assisted England against him. In the year 1588, Philip, having resolved to distress Elizabeth, fitted out a fleet called the Invincible Armada. It consisted of 150 large ships, on board of which were mounted 2650 pieces of cannon, 8000 seamen, 20,000 soldiers, and the flower of the Spanish nobility. This fleet, commanded by the Duke of Medina Sidonia, sailed from Lisbon when the season was too far advanced; and, being overtaken by a violent storm, a great part of it was dispersed. Twelve ships, driven upon the coast of England, were captured by the English fleet, which consisted of 100 sail; fifty were wrecked upon the coasts of France, Scotland, Ireland, Holland, and Denmark. Such was the disastrous fate of an expedition, from which nothing less than the subjugation of England had been anticipated.

This enterprise, which cost Spain forty millions of ducats, 20,000 men, and 100 ships, was productive only of disgrace. But Philip supported his misfortune with heroic resolution. When one of his courtiers told him, with an air of consternation, what had happened, he coolly replied, "I sent to fight the English, and not the winds. God's will be done." The day after, Philip ordered the bishops to return thanks to God for having preserved some remains of his fleet; and he wrote thus to the pope: "Holy father, as long as I remain master of the fountain-head, I shall not much regard the loss of a rivulet. I will thank the Supreme Disposer of empires, who has given me the power of easily repairing a disaster which my enemies must attribute solely to the elements, that have fought for them."

At the same time that Philip openly attacked England, he was secretly encouraging the league in France, the object of which was to overturn the throne and divide the state. The leaguers conferred upon him the title of protector of their association, which he eagerly accepted, from a persuasion that their exertions would soon conduct him, or one of his family, to the throne of France. So sure did he think himself of his prey, that when speaking of the principal cities in France, he used to say, "my fine city of Paris, my fine city of Orleans," in the same manner as he would have spoken of Madrid or Seville. What was the result of all these intrigues? Henry IV. embraced the Catholic religion, and by his abjuration of Protestantism annihilated the hopes of his rival.

At length Philip, worn out by the debaucheries of his youth, and by the toils of government, drew near to his last hour. But a slow fever, the most painful gout, and a complication of other disorders, could not disengage him from business, or draw from him the least complaint. "What," said he to the physician, who hesitated about letting blood of him, "are you afraid of drawing a few drops of blood from the veins of a king who has made whole rivers of it flow from heretics?" At last, exhausted by a complication of disorders, which he bore with heroic patience, he expired on the 13th of September 1589, aged seventy-two years, after a reign of forty-three years and eight months. During the last fifty days of his illness he showed a deep sense of religion, and had his eyes almost constantly turned towards heaven.

No character was ever drawn by different historians in more opposite colours than that of Philip; and yet, considering the length and activity of his reign, there is none which it should seem more easy to ascertain. From the facts recorded in history, we cannot doubt that he possessed, in an eminent degree, penetration, vigilance, and a capacity for government. His attention was continually directed towards every part of his extensive dominions. He entered into every branch of administration; watched over the conduct of his ministers with unwearied attention; and in his choice both of them and of his generals discovered a considerable share of sagacity. He had at all times a composed and settled countenance, and never appeared to be either elated or depressed. His temper was the most imperious, and his looks and demeanour were haughty and severe; yet amongst his Spanish subjects he was of easy access, listened patiently to their representations and complaints, and, where his ambition and bigotry did not interfere, was generally willing to redress their grievances. But when we have said this much in his praise, we have said all that truth requires or truth permits. It is indeed impossible to suppose that he was insincere in his zeal for religion. But as his religion was of the most corrupt kind, it served to increase the natural depravity of his disposition; and not only allowed, but even prompted him to commit the most odious and shocking crimes. Although a prince in the bigoted age of Philip might be persuaded that the interest of religion would be advanced by falsehood and persecution, yet it might have been expected that, in a virtuous prince, the sentiments of honour and humanity would on some occasions triumph over the dictates of superstition. But of this triumph there occurs not a single instance in the reign of Philip, who, without hesitation, violated his most sacred obligations as often as religion afforded him a pretence for doing so; and, under that cloak, he exercised for many years the most unrelenting cruelty without reluctance or remorse. His ambition which was exorbitant, his resentment which was implacable, his arbitrary temper which would submit to no control, concurred with his bigoted zeal for the Catholic religion, and carried the sanguinary spirit which that religion was supposed to inspire, to a greater height in Philip than it had ever attained in any other prince of that or of any previous or succeeding age.

Although of diminutive size, he had an agreeable person. His countenance was grave, his air tranquil, and one could not discover from his looks either joy in prosperity or chagrin in adversity. The wars against Holland, France, and England, cost Philip 564 millions of ducats; but America furnished him with more than the half of that sum. His revenues, after the junction of Portugal, are said to have amounted to twenty-five millions of ducats, of which he only laid out 100,000 for the support of his own household. Philip was very jealous of outward respect; and he was unwilling that any person should speak to him except kneeling. The Duke of Alva having one day entered his cabinet without being introduced, the king, with a stormy countenance, exclaimed, "An impudence like this of yours would deserve the hatchet." If he thought only how to make himself be feared, he succeeded in doing so; for few princes have been more dreaded, more abhorred, or have caused more blood to flow, than Philip II. of Spain. He had successively, if not all at once, to maintain war against Turkey, France, England, Holland, and almost all the Protestant states of the empire, without having a single ally, not even the branch of his own house in Germany. But, notwithstanding so many millions employed against the enemies of Spain, Philip found in his economy resources wherewith to build thirty citadels, sixty-four fortified places, nine seaports, twenty-five arsenals, and as many palaces, without including that of the Escorial. His debts amounted to 140 millions of ducats, of which, after having paid seven millions of interest, the greater part was due to the Genoese. Moreover, he had sold or alienated a capital stock of 100 millions of ducats in Italy. He made a law, fixing the majority of the kings of Spain at fourteen years of age. He affected to be more than commonly devout; he ate often at the refectory with the monks; he never entered the churches without kissing all the relics they contained; he caused his bread to be kneaded with the water of a fountain which was thought to possess a miraculous virtue; he boasted of never having danced, and of never wearing breeches after the Grecian fashion. Grave and solemn in all his actions, he drove from his presence a lady who had incautiously smiled whilst he was blowing his nose. One great event of his domestic life is the death of his son Don Carlos. The manner of this prince's death is not certainly known. His body, which is interred in the Escorial, built by Philip in execution of his vow on the field of battle, is there separated from his head; but it is pretended that the head is separated only because the leaden coffin which contains the body proved too small. The particulars of his crime are as little known as the manner in which it was committed. There is no evidence, nor is there any probability, that Philip had caused him to be condemned by the Inquisition. All that we know of the matter is, that in 1568 his father, having discovered that he had some correspondence with the Hollanders, arrested him in his own room, and had him placed in confinement. At the same time he wrote to Pope Pius V. giving him an account of his son's imprisonment; and in his letter to the sovereign pontiff, dated the 20th of January 1568, he says, "that from his earliest years the strength of a wicked nature has stifled in Don Carlos every paternal instruction." It was Philip II. who caused to be printed at Antwerp, between 1569 and 1572, in eight vols. folio, the fine Polyglot Bible which bears his name; and it was also he who subjected the islands afterwards called the *Philippines.*

Philip *Island* is an uncultivated but fruitful island, abounding in herbage, in the South Pacific Ocean, situated about six miles to the south of Norfolk Island. That it might be rendered as useful as possible to the British settlements on the shores of New Holland, the governor turned loose some hogs on it, in the hopes that they would multiply; and also sent some cows, with several settlers to take care of them. Owing, however, to the difficulty of approaching this island, from the tempestuous seas which constantly rage around its shores, it was at length wholly abandoned. This is also the name of a small island on the east coast of New Holland, which shelters Western Port. Long. 145. 25. E. Lat. 38. 33. S.

Philip *Islands*, two islands in the South Pacific Ocean, discovered in 1791, by Captain Hunter. They are joined together by a long sandy isthmus above water; and a sandbank extends from the largest island above half a mile into the sea. They are very dangerous to ships in the night. Long. 140. 3. E. Lat. 8. 6. S. This is also the name of an island in the South Pacific Ocean, discovered by Captain Turnbull. Long. 143. 57. W. Lat. 16. 24. S.

Philip *Port*, an inlet on the southern coast of New Holland, which extends about thirty miles into the land in a northerly direction. Long. of Point Nepean, the eastern point of the entrance, 144. 38. E. Lat. 38. 18. S.

PHILIPPI, a town of European Turkey, in Macedonia, at the foot of Mount Pangæus, eight miles from the seashore, and twenty-six leagues to the eastward of Salonica. On the plain near it was decided the fate of Rome in the battle fought by Augustus and Marc Antony on the one side, against Brutus and Cassius on the other. The place still exhibits the remains of an amphitheatre, and several other monuments of its antiquity and prosperity, although at present it has an inconsiderable population.

PHILIPPICS, Φιλιππικοι λογοι, in literature, is a name applied to the orations of Demosthenes against Philip king of Macedonia. The Philippics are reckoned the masterpieces of that great orator. This name is likewise applied to the fourteen orations of Cicero against Marc Antony.

PHILIPPINES. This archipelago, in the Eastern Seas, extends from the fifth to the twentieth degree of north latitude, and consists of a great number of islands of various sizes, and many of which are but little known. The largest of the group is Luzon or Luconia; and to the south lie the other principal islands, namely, Mindoro, Panay, Marindique, Negros, Masbate, Zebu, Bohol, Leyte, Samar, and Magindanao. There are, besides, several smaller ones, and they are all, nominally at least, subordinate to the Spanish government at Manilla; but its power does not extend over all parts of the islands. There are many remote places to which the Spaniards have never been able to penetrate. Amongst their fastnesses and mountains, the natives roam in a state of barbarous independence, and wage an inveterate war against their Spanish oppressors. These islands, which are partially colonized, pay tribute, which is collected by the Spanish magistrates in the provinces or districts into which the country is subdivided. The appellation of Philippines was given to them in compliment to Philip II. of Spain, who at the time of their subjugation was prince of the Asturias.

The Philippines, from their situation, possess a tropical climate, and are subject to the periodical rains, though the heats are moderated by the breeze from the sea. The rains generally commence in May, and last till September, but sometimes they are protracted to the beginning of December; from which latter period till the succeeding May the weather is delightful, being a perpetual spring. The vegetation is luxuriant, owing to the copious rains; the trees are constantly covered with leaves, and the soil with verdure, so that it is difficult to keep the land clear of weeds and insects. The winds which most commonly prevail are the north, the east, and the south-west, each of which continues for four months; the change of wind being attended with violent storms of thunder and lightning, and at times by whirlwinds. These storms rage occasionally with frightful violence, and blow from every point of the compass in the course of twenty-four hours, ravaging and destroying the country, and tearing up trees by the roots.

These islands, from their extent, their climate, and the fertility of their soil, would produce all sorts of colonial products, if there were adequate industry on the part of the inhabitants. Their chief production, however, is rice, which is the principal subsistence of the natives. They cultivate, besides the bread-fruit, beans, the cacavata, &c.; and the palm-tree is much attended to, as it yields a spirit and an oil, besides a sweetmeat named chanaca. The pith of the palm, the young shoots of the sugar-cane, green withes, and other succulents, serve as substitutes for rice to those who cannot procure anything better. The other products are different sorts of pulse, such as mangos, patani, kidney beans, and millet. They have not many fruit-trees, and they are, besides, of an indifferent quality, excepting the plantain, to which may be added the orange and the mango. The areca or betel-nut is also cultivated, and used in great quantities, both by Spaniards and by natives. The domestic animals are buffaloes, goats, pigs, ducks, and fowls. Horses and horned cattle, having been imported in great numbers by the Spaniards, have multiplied to such a degree that they now run wild in the mountains, without being claimed by any owner. Deer abound in the mountains, and all sorts of pigeons swarm in the fields, with other small birds, such as quails, a species of partridge, woodcocks, &c. The swallow which builds the edible bird-nests so much esteemed by the Chinese is found here. The surrounding seas yield abundant supplies of fish, which afford a wholesome nourishment to the inhabitants. The natives take a great delight in fishing, as it flatters their natural indolence, and gives them a supply of fish, which they prefer to flesh. Shells in great variety are found upon the shores; amongst these are the cowries, and the enormous kima cockle, so large as to hold a gallon, and used in the churches as vessels for containing holy water. They have also introduced sheep, as well as geese; and amongst vegetables, grapes, figs, wheat, pepper, cocoa, coffee, sugar, tobacco, and various sorts of plants, which have thriven remarkably well.

These islands contain many valuable mineral productions. In the interior there are mines of gold and of iron, but they are not worked, either from a deficiency of produce, or from the want of skill and industry amongst the inhabitants. Gold is also procured by washing the sand which is found in the mountain streams. At one place the gold mines are so indolently worked as scarcely to defray the expense. The mountains abound in excellent timber, both for ship and house building; and the bamboos are large and long. Some of them are of the thickness of a man's thigh; and of these the native houses are constructed, after which they are covered with palm-leaves. The inhabitants also raise a little cotton for clothing, which is dyed with indigo, logwood, &c. The other productions of the Philippines which are articles of export, consist of wax, wild honey, amber, marble, tar, brimstone, and other lesser articles.

These islands, notwithstanding their natural fertility, continue in a very desolate state, which is owing partly to physical disadvantages, namely, the hurricanes, which sweep across the country with wide-wasting desolation, and to the destruction caused by rats, insects, and other vermin, which swarm in all parts, and are a great annoyance; partly also to the indolence of the natives, and to the intolerant and illiberal policy of the Spaniards. If the Chinese were encouraged by an enlightened government, they would settle in great numbers in these islands, and by their enterprise and industry would soon change the face of the country. These islands import a variety of piece-goods, especially ordinary long cloth, white, blue, and red; handkerchiefs of all kinds; chintz, principally dark grounds; Surat goods of most sorts, and all kinds of European cutlery and iron. The exports are the edible bird-nests, cassia, gold-dust, pepper, rattans, sago, tortoise-shell, wax, wild honey, amber, marble, tar, brimstone, and other articles of inferior note. The native Indians trade with each other for the different productions of their country, and employ gold as the medium of exchange. They likewise carry on a trade, though inconsiderable, with the Chinese and the Malays of Borneo, for flag-stones, copper, and articles of furniture. They are rude in their manners, and go about almost naked. These islands are visited by junks which come from several parts of the Chinese empire, bringing various articles for the consumption of the numerous resident Chinese, and silk-goods, lackered ware, china-ware, and teas, for the Acapulco ships. Cochineal, black wood, and dollars, constitute the returns. A trade is also carried on with the British settlements, though not to any great extent.

The Spaniards who first visited these islands spread the most extraordinary and incredible tales of their inhabitants, whom they described as divided into three classes, satyrs, men with tails, and sea-monsters. There were only in these islands two races, the Bisayan Indians, and that strange race of oriental negroes who still occupy the Papuan Isles. The latter roamed the mountains almost in a state of nature, merely covering the fore-part of the body with the bark of a tree, and living on roots, or on such animals as they could kill with their bows and arrows, and the flesh of which they devoured raw. In short, they were nearly on a level in their habits and manners with the beasts of the forest. The Spaniards have succeeded in domesticating them, and introducing amongst them an imperfect civilization. But their barbarous aversion to labour they have never been able to conquer. They are of opinion that the negroes were the indigenous inhabitants of the islands, and that the Bisayans were intruders. At present the Papuans are few in number, and consequently feeble; yet they retain all their original hatred to the Bisayans, whom they lie in wait for and murder without remorse. There are, besides, several other races who inhabit the Philippines, and differ in features, language, and manners. The Pampangos reside to the north of Manilla, as also the painted races termed by the Spaniards Pintados, from whom these islands were originally named Islas de Pintados. The Indians found by the Spaniards in these islands were of regular stature, and an olive complexion, with flat noses, large eyes, and long hair. They were all governed by their chiefs, and their different villages waged an everlasting war with each other. The prisoners on each side were condemned to slavery. In some places a race of Indians was discovered whiter than the others, the descendants, as is supposed, of Chinese who had been wrecked on the coasts, and who had intermarried with Indians. The tribes of Igorrates or Ilocas, in particular, have eyes resembling the Chinese. Their customs and usages mark a barbarous people. They have no fixed laws. Certain traditions are the only rules which they have for deciding civil suits; and criminal cases are generally compounded for a sum of money, unless in cases of murder, where one tribe retaliates upon another, and a scene of bloody contention ensues. They are permitted to have only one wife. But the principal persons have several concubines, who are slaves. No great reformation of manners has been effected by the Spaniards, nor have they made any great progress in the conversion of the natives. The Tagala or Gala language is in general use throughout the Philippine Islands. The dialects are so many and various, that the inhabitants of one province are not intelligible in those of another; yet their language is all derived from one common stock. Their religion is a rude species of idolatry, and consists in frantic ceremonies and sacrifices to idols, of which the details would be of little interest.

These islands were discovered in 1521, by Magelhaens, who named them the Archipelago of St Lazarus. In 1565 they were taken possession of by a fleet which was despatched from Mexico, in consequence of orders from Philip II. of Spain, and first stopped at the island of Zebu, which was soon wholly subdued. In 1570 a fleet sailed from the island of Panay for Luzon, and, after several engagements with the princes of the country, effected a settlement at the mouth of the Manilla River. In 1571 the Spanish admiral took possession of the town of Manilla, which he constituted the capital of the Spanish possessions in the Philippines, and proceeded in his reduction of the island under the Spanish authority. In 1574 the existence of the Spanish settlement was threatened by a Chinese pirate, who arrived with sixty-two junks; but, after many bloody engagements, he was expelled, and great part of his army destroyed. Towards the conclusion of the sixteenth century a considerable trade was openly carried on with Japan; and many rich cargoes were brought from that country to Manilla, which had now become an emporium of the trade with China, Java, the coast of Coromandel, and Mexico. In 1590 the island of Sooloo was attacked by the Spaniards, but they were repulsed with great slaughter by the natives; nor could the Spanish maritime force make any impression on the Sooloo pirates, who have continued for nearly three centuries the scourge of these seas. The number of industrious Chinese had been daily increasing in the Philippines, and about the year 1639 they amounted to 30,000, most of whom were settled as cultivators. The Spaniards were always jealous of them, though they enriched the country by their industry; and that year, in consequence of suspected disaffection, they commenced a war against them, and made so dreadful a havoc amongst them, that in a short time their numbers were diminished to 7000, who surrendered at discretion. In 1757, the Chinese, who had again increased in the island, were all banished to their own country; and, to prevent their future establishment in the archipelago, the quarter of St Fernando was appropriated for the reception of such Chinese as should come to the island for the purposes of commerce, and regulations were made for their re-embarkation in good time, unless they should be in the mean time converted to the Christian religion, in which case they were permitted to settle as cultivators. In 1762, Manilla was attacked by a British fleet under Admiral Cornish and General Draper, and the place was stormed on the 5th of October. A capitulation was agreed upon next day, when, in order to redeem the city from general plunder, a ransom was agreed upon of four millions of dollars. Manilla was restored to the Spaniards at the peace of 1763, and has ever since remained in their possession. Besides Manilla and the larger establishments in Luzon, the Spaniards have many smaller settlements scattered over the islands to the southward; but such is the weakness of their government, that they have never been able to protect them against the attacks of the pirates who infest these seas. And so jealous of the natives are the Spanish rulers of these islands, that, though unable to defend them, they do not allow the natives to possess arms, or any sort of iron, which is a royal monopoly. In the year 1809 they published a declaration of their adherence to Ferdinand VII. and opened their ports to the British; and since that period a free trade has been carried on to a considerable extent. (F.)

PHILIPPISTS, a sect or party amongst the Lutherans, who followed Philip Melancthon. He had strenuously opposed the Ubiquists, who arose in his time; and the dispute growing still hotter after his death, the members of the university of Wirtemberg, who espoused Melancthon's opinion, were called by the Flacians, who attacked it, *Philippists.*

PHILIPPOPEL, a city of Turkey in Europe, in the government of Rumelia, and in the department of Sofla, the Turkish name of which is Filibé. It stands upon a plain, watered by the river Maritza, which is to a certain extent navigable, in a beautiful situation, on the great road from the frontiers to Constantinople. It is a well-built place, and has twenty mosques, two caravanserais, several Greek and Armenian churches, and many public and private baths. It is the seat of a Greek archbishop, and also a manufacturing city, in which woollen, silk, and cotton goods are made; and there are some very extensive tanneries. The commodities thus produced form a portion of the exports, to which are added raw materials, such as wool and silk. A great quantity of rice is grown on the banks of the river, and much tobacco, as well as abundance of grapes, on the more elevated parts. The inhabitants are stated to be about 30,000.

PHILIPS, Fabian, the author of several books relating to ancient customs and privileges in England, was born at Prestbury in Gloucestershire, on the 28th of September 1601. When very young, he spent some time in one of the Inns of Chancery, and went from thence to the Middle Temple, where he became learned in the law. In the civil wars, he was a bold assertor of the king's prerogative, and so strongly attached to Charles I. that, two days before that monarch was beheaded, he wrote a protestation against the intended murder, and caused it to be printed, and affixed to posts in all the public places. He likewise published, in 1649, a quarto pamphlet entitled *Veritas Inconcussa*, or King Charles I. no Man of Blood, but a Martyr for his People, which was reprinted in 1660, 8vo. In 1663, when the courts of justice at Westminster, especially the chancery, were dissolved by Cromwell's parliament, he published Considerations against the dissolving and taking them away, for which he received the thanks of parliament. He was for some time filazer for London, Middlesex, Cambridgeshire, and Huntingdonshire; and spent much money in searching records, and writing in favour of the royal prerogative. The only advantage he received for this attachment to the royal cause was the place of commissioner for regulating the law, worth L.200 per annum, but which only lasted two years. After the restoration of Charles II. when the bill for taking away the tenures was depending in parliament, Philips wrote and published a book to show the necessity of preserving them, entitled *Tenenda non Tollenda*, or, the Necessity of preserving Tenures *in capite*, and by Knight's Service, which, according to their first institution, were, and are yet, a great part of the *salus populi*, 1660, in 4to. In 1663 he published the Antiquity, Legality, Reason, Duty, and Necessity of Pre-emption and Purveyance for the King, in 4to; and afterwards many other pieces upon subjects of a similar kind. He assisted Dr Bates in his *Elenchus Motuum*, especially in searching the records and offices for that work, and died on the 17th of November 1690, in his eighty-ninth year. He was a man well acquainted with records and antiquities; but his manner of writing is neither close nor well digested. He published a political pamphlet in 1681, entitled *Ursa Major et Minor*, "showing that there is no such fear, as is fictitiously pretended, of popery and arbitrary power."

Philips, *Ambrose*, an English poet of some note, was descended from an ancient and considerable family of that name in Leicestershire. He received his education at St John's College, Cambridge, and during his stay there wrote his pastorals, which at that time acquired him a high reputation. His next performance was the Life of Archbishop Williams, written, according to Mr Cibber, to make known his political principles, which in the course of it he had an opportunity of doing, as the archbishop, who is the hero of his work, was a strong opponent of the high-church party and their measures.

When he quitted the university and went to London, Philips became a constant attendant at, and one of the wits of, Button's coffee-house, where he obtained the friendship and intimacy of many celebrated men of that age, particularly of Sir Richard Steele, who, in the first volume of his Tatler, has inserted a little poem of Philips's, which he entitles a Winter Piece, dated from Copenhagen, and addressed to the Earl of Dorset, and on which he bestows the highest encomiums; and, indeed, so just are these commendations, that even Pope himself, who had a fixed aversion to the author, whilst he affected to despise his other works, used always to except this from his censure and contempt.

The first dislike Pope conceived against Philips proceeded from that jealousy of fame which was so conspicuous in his character; for Sir Richard Steele had taken so strong a liking to the pastorals of Philips, that he formed a design of instituting a critical comparison of them with those of Pope, in the conclusion of which the preference was to be given to Philips. This design, however, having come to the knowledge of Pope, the latter, who could not bear a rival near the throne, determined to ward off this stroke by a stratagem of the most artful kind; which was no other than taking the same task on himself. Accordingly, in a paper in the Guardian, he drew a similar comparison, and gave a like preference, but on principles of criticism so evidently fallacious, as to point out to all the absurdity of the decision. However, notwithstanding the ridicule which Philips drew upon himself by standing as it were in competition with so powerful an antagonist, it is allowed that in some parts of his pastorals there are certain touches of nature, and a degree of simplicity, which are much better suited to the purposes of pastoral than the more correctly-turned periods of Pope's versification. Philips and Pope being of different political principles, proved another cause of enmity between them, which at length arose to so great a height, that the former, finding his antagonist too hard for him at the weapon of wit, had determined upon making use of a rougher kind of argument; and for this purpose he even went so far as to hang up a rod at Button's for the chastisement of his adversary whenever he should come thither. Pope, however, declining to brave his antagonist, avoided the *argumentum baculinum*, in which he would, no doubt, have found himself on the weaker side of the question. Our author also wrote several dramatic pieces, as the Briton, Distressed Mother, and Humphrey Duke of Gloucester, all of which met with success, and one of them still continues to be a standard entertainment at the theatres, being generally repeated several times in every season. Philips's circumstances were throughout his life not only easy, but rather affluent, in consequence of his being connected, by political principles, with persons of great rank and consequence. He was concerned with Dr Hugh Boulter, afterwards archbishop of Armagh, the Right Honourable Richard West, lord chancellor of Ireland, the Rev. Gilbert Burnet, and the Rev. Henry Stevens, in writing a series of papers under the title of the *Freethinker*, which were all published together by Philips, in three volumes 12mo.

In the latter part of Queen Anne's reign, he was secretary to the Hanover Club, a set of noblemen and gentlemen who had formed an association in honour of that succession, and for the support of its interests, and who used particularly to distinguish in their toasts such of the fair sex as were most zealously attached to the illustrious house of Brunswick. Philips' station in this club, together with the zeal shown in his writings, recommended him to the notice and favour of the new government. Soon after the accession of George I., he was put into the commission of the peace, and appointed one of the commissioners of the lottery; and, on his friend Dr Boulter being made primate of Ireland, he accompanied that prelate across St George's Channel, where considerable preferments were bestowed on him, and he was elected a member of the Irish House of Commons, as representative for the county of Armagh. At length, having purchased an annuity for life of L.400 per annum, he returned to England some time in the year 1748; but being in a very bad state of health, and, moreover, at an advanced age, he died soon afterwards, at his lodgings near Vauxhall, in Surrey.

Philips, *Catharine*, an ingenious lady, the daughter of Mr John Fowler, merchant, was born at London in January 1631, and educated at a school near Hackney. She married James Philips of the priory of Cardigan; and went with the Viscountess of Dungannon into Ireland, where she translated into English Corneille's tragedy of Pompey, which was several times acted there with great applause. She also translated the first four acts of the Horace, another tragedy of Corneille, the fifth being executed by Sir John Denham. This remarkable person died of the small-pox in London on the 22d of June 1664, much and justly regretted; "having," according to Langbaine, "not left any of her sex her equal in poetry." Dr Jeremy Taylor addressed to her his Measures and Offices of Friendship, the second edition of which appeared in the year 1657, in 12mo. Her assumed poetical name was *Orinda*.

Philips, *John*, an English poet of considerable eminence, was born in 1676. He was educated at Winchester and Oxford, where he became acquainted with Milton, whom he studied with great application, and traced in all his successful translations from the ancients. The first poem by which he distinguished himself was his Splendid Shilling, which in the Tatler is styled the "finest burlesque poem in the English language." His next was entitled Blenheim, which he wrote at the request of the Earl of Oxford, and Mr Henry St John, afterwards Lord Bolingbroke, on the victory obtained by the Duke of Marlborough in the year 1704. It was published in 1705; and the year after, he finished another poem upon cider, the first book of which had been written at Oxford. It is on the model of Virgil's Georgics, and is thought a very excellent piece. We have no more of Philips' except a Latin ode to Mr Henry St John, which is esteemed a masterpiece. He was contriving greater things, when he was seized with the illness of which he died, at Hereford, on the 15th of February 1708, before he had attained his thirty-third year.

It deserves to be remarked, that there were other two poets of the same name who flourished in his time. One of these was Milton's nephew, who wrote several things, particularly some memoirs of his uncle, and part of Virgil Travestied. The other was the author of two political farces, which were both printed in 1716, viz. The Earl of Marr Married, with the Humours of Jockey the Highlander; and the Pretender's Flight, or a Mock Coronation, with the Humours of the facetious Harry St John.

PHILISTINES were the ancient inhabitants of Palestine, well known in sacred history. These people are sometimes called in Scripture Cherethites and Caphtorim. The earlier part of their history is, like that of most other nations, very obscure and uncertain. The authors of the Uni-

Philistines.

versal History inform us that they were descended partly from the Casluhim, and partly from the Caphtorim, both being of the progeny of Mizraim, the son of Ham, the son of Noah. Moses tells us that they drove out the Avim or Avites even to Azzah or Gazah, where they settled; but when this happened cannot be determined. Upon the whole, however, our learned authors are clearly of opinion, that the Casluhim and Caphtorim, from whom the Philistines were descended, came originally from Egypt, and called the country which they had conquered by their own name. Many interpreters, however, think that Caphtor was but another name for Cappadocia, which they imagine to have been the original country of the Philistines. But Calmet, in a particular dissertation prefixed to the first book of Samuel, endeavours to show that they were originally from the island of Crete. The reasons which led him to think that Caphtor is the island of Crete may be shortly stated. The Philistines were strangers in Palestine, as appears from various parts of Scripture; and hence the Septuagint always translate this name *strangers*. Their proper name was Cherethim; for Ezekiel, speaking against the Philistines, says, "I will stretch out mine hand upon the Philistines, and I will cut off the Cherethim, and destroy the remnant of the sea-coast." Zephaniah, inveighing against the same people, says, "Woe unto the inhabitants of the sea-coasts, the nation of the Cherethites." And Samuel says, that the Amalekites made an irruption into the country of the Cherethites, that is, of the Philistines, as the sequel of the discourse plainly proves. The kings of Judah had afterwards foreign guards called the Cherethites and Pelethites, who appear to have been Philistines. The Septuagint, under the name of Cherethites, understood the Cretans; and by Cherith they understood Crete. Besides, the Scripture says that the Philistines came from the isle of Caphtor. Now we know of no island in the Mediterranean in which the marks whereby the Scripture describes Caphtor and Cherethim agree better than in the island of Crete. The name Cretim or Cherethim is the same with that of Cretenses; and the Cretans are a most ancient and celebrated people, who inhabited the islands of the Mediterranean, pretending to have been originally produced out of their own soil. This island was well peopled in the time of the Trojan war. Homer calls it the island of the hundred cities. The city of Gaza in Palestine went by the name of Minoa, because Minos, king of Crete, coming into that country, called this ancient city by his own name.

Herodotus acknowledges that the Cretans were originally barbarians, and did not come from Greece. Homer says, that a different language was spoken in the island of Crete; that there were Greeks there, but also true or ancient Cretans, and Pelasgians. The ancient Cretans are the same as the Cherethites, and the Pelasgians as the Philistines or Pelethites of the Scripture. Their language was the same with that of the Canaanites or Phœnicians, that is, Hebrew; and they were descended, as well as Canaan, from Ham, by Mizraim. The manners, arms, religion, and gods of the Cretans and Philistines were the same. Both used only bows and arrows; and Dagon the god of the Philistines was the same as the Dictymna of the Cretans.

Whether these arguments are convincing, it is not for us to determine. Wells does not think they are, being of the same opinion with the authors of the Universal History, who say that Coptus, the name of an old city of Egypt, is a corruption of the ancient Caphtor. It is not, however, of great importance to determine whether they came from Crete, from Cappadocia, or from Egypt. They had certainly been a considerable time in the land of Canaan when Abraham arrived there in the year of the world 2083. They were then a very powerful people, governed by kings, and in possession of several considerable cities. The race of kings then in power were honoured with the title of *Abimelech*. This race, however, was of short duration; for their monarchy became an aristocracy of five lords, who, as far as we can discover, were partly independent of one another, though they acted in concert for the common cause. This form of government was again succeeded by another race of kings, distinguished by the title of *Achish*, though they also bore that of Abimelech. The kings were always subjected to great limitations. The Philistines appear to have been a very warlike people, industrious, and lovers of freedom; they did not circumcise, and in the early periods of their history held adultery in the greatest abhorrence. "Their character," say the authors of the Universal History, "must be considered at different periods; for we may say they were not always the same people. In the days of Abraham and Isaac, they were without all doubt a righteous and hospitable nation; but afterwards a revolution in government, religion, and morals, may have ensued. From thenceforward they became like the other idolatrous nations; the same enormities crept in and prevailed amongst them. They are constantly mentioned in Scripture as strangers; and though possessed of a very considerable part of the Land of Promise, yet God would never suffer them to be driven out, they being Egyptians by descent, and not original natives, whose land only was promised to Abraham and his seed. Their arrogance and ambition were great; and so irreconcileable was their enmity to the Israelites,[1] that one would be almost tempted to think they were created on purpose to be a thorn in their sides; for though the hand of God was evidently against them several times, and particularly when they detained the ark, yet they hardened their hearts and closed their eyes against conviction. They seem to have entertained a very great veneration for their deities, in which they persisted, though they were eye-witnesses of the shame and ignominy which befell them in the presence of the captive ark; nay, they were so biassed in their favour, as to imagine that their gods might prevail against Him who had in so glaring a manner put them to shame and disgrace. They were much engaged in trade, which, considering their situation, they may have exercised from the beginning; but, by the accession of the fugitive Edomites in David's time, they rose to so great a reputation as merchants, that the Greeks, it seems, preferred them to all other nations in that respect, and from them called all the country bordering upon theirs *Palestine*. Their language was not so different from that spoken by the Hebrews as to cause any difficulty for them to converse together, as will be perceived by their intercourse with Abraham and Isaac; so that, in all this region, the several nations spoke one and the same tongue, perhaps with some variation of dialect. They had doubtless the arts and sciences in common with the most learned and ingenious amongst their contemporaries, and perhaps some of them in greater perfection. They had giants amongst them; but whether these were originally of the breed of the Anakim, who retired hither when they were expelled from Hebron, or were sprung from accidental births, is not easily determined. We must not forget, that the invention of the bow and arrow is ascribed to this people.

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[1] "From a passage in Chronicles, where it is said, that 'the men of Gath slew the children of Ephraim, who would have taken their cattle from them,' it is guessed to have been of very ancient date. This incident is nowhere else to be found; and there are various notions concerning the sense in which we must take this passage. As to the time of the transaction, most people allow it to have been while the children of Israel were sojourners in Egypt. It plainly appears, by the next verse, that Ephraim himself was living at that period. The Targum supposes his children miscomputed the time they were to serve in Egypt, and began too early an attempt upon their promised land."

Philistines.

"Their religion was different at different times; under their first race of kings, they used the same rites with the Hebrews. Abimelech, in the sin he had like to have committed with Sarah, through Abraham's timidity, was favoured with a divine admonition from God; and, by his speech and behaviour at that time, it seems as if he had been used to converse with the Deity. In after times, they fell into endless superstitions, and different kinds of idolatry; nay, each of the principal or five cities seemed to have an idol of its own. Marna, Marnas, or Marnash, was worshipped at Gaza, and is said to have migrated into Crete, and to have become the Cretan Jupiter. Dagon was worshipped at Azotus; he seems to have been the greatest, the most ancient, and most favourite god they had; to which may be added, that he perhaps subsisted the longest of any that did not straggle out of the country. To him they ascribed the invention of bread-corn, or of agriculture, as his name imports. We cannot enter into the common notion of his being represented as a monster, half man, half fish; nor consequently into another, almost as common, that he is the same with the Syrian goddess Derceto, who, we are told, was represented under some such mixed form. Our opinion is, that this idol was in shape wholly like a man; for we read of his head, his hands, and his feet. He stood in a temple at Azotus, and had priests of his own, who paid him a very constant attendance. Next to Dagon was Baalzebub, the god of Ekron. In the text of the New Testament he is called *Beelzebub*, and the 'prince of devils.' His name is rendered *lord of flies*, which by some is held to be a mock appellation bestowed on him by the Jews; but others think him so styled by his worshippers, as Hercules Apomyios and others were, from his driving those insects away; and urge, that Ahaziah, in his sickness, would scarcely have applied to him, if his name had carried in it any reproach. But it must be remembered, it is the sacred historian that makes use of that contemptuous term in derision; whereas the idolatrous monarch, who was one of his votaries, might call him by his common name, supposed to have been *Baal-zeboath*, 'the lord of armies,' or *Baal-shamin*, 'lord of heaven,' or some other bordering on Baal-zebub. How or under what form he was represented is uncertain. Some place him on a throne, and attire him like a king; others paint him as a fly. Not to dwell on this obscurity, it appears that he became an oracle of the highest repute for omniscience and veracity; that he had priests of his own; and that he, in the middle times at least, was much sought after by those who were anxious about futurity. Derceto we take certainly to have been the goddess of Ascalon; but we are supported by profane authority, without the least countenance from Scripture. Gath is seemingly the only city of all the five unprovided with a deity; wherefore, as the Scripture declares, that Ashtaroth, or Astarte, was worshipped by this people, we are ready to place her at Gath, and the rather, as this of all their cities may have had most communication with Sidon. To speak in general concerning their religious rites and ceremonies, which is all we can do, they seem to have erected very large and spacious temples, or very wide halls, for the celebration of their solemn seasons and festivals (for such they surely had); their religious offices were attended with much pomp, and a great concourse from all parts; and they presented their gods with the chief part of their spoil, and carried them about with them when they went to war. We do not find in Scripture that they sacrificed their children; and yet the Curetes are said to be their descendants."

With respect to the history of this extraordinary people, we find from the above extract, that they were not comprehended in the number of nations devoted to extermination, and whose territory the Lord had abandoned to the Hebrews; nor were they of the cursed seed of Canaan. However, Joshua did not forbear to give their lands to the Hebrews, and to set upon them by command of the Lord, because they possessed a country which was promised to the people of God. But these conquests of Joshua must have been ill maintained, since under the Judges, under Saul, and at the beginning of the reign of David, the Philistines oppressed the Israelites. It is true that Shamgar, Samson, Samuel, and Saul, made head against them, but did not reduce their power; and they continued independent down to the reign of David, who subjected them to his government.

They remained in subjection to the kings of Judah down to the reign of Jehoram, the son of Jehoshaphat, that is, for about 246 years. However, Jehoram made war against them, and probably reduced them to obedience; because it is observed in Scripture that they revolted again under Uzziah, and that this prince kept them to their duty during the remainder of his reign. During the unfortunate reign of Ahaz, the Philistines made great havoc in the territories of Judah; but his son and successor Hezekiah subdued them. Lastly, they regained their full liberty under the latter kings of Judah; and, by the menaces denounced against them by the prophets Isaiah, Amos, Zephaniah, Jeremiah, and Ezekiel, we find that they had brought a thousand hardships and calamities upon the children of Israel, for which cruelties God threatened to punish them. Esarhaddon besieged Ashdod or Azoth, and took it; and, according to Herodotus, Psammeticus king of Egypt took the same city, after a siege of twenty-nine years. There is great probability that Nebuchadnezzar, when he subdued the Ammonites, Moabites, Egyptians, and other nations bordering upon the Jews, also reduced the Philistines. After this, they fell under the dominion of the Persians, and then under that of Alexander the Great, who destroyed the city of Gaza, the only city of Phœnicia which ventured to oppose him. After the persecution of Antiochus Epiphanes, the Asmonæans subjected to their sway several cities of the Philistines; and Tryphon gave to Jonathan Maccabæus the government of the whole coast of the Mediterranean, from Tyre as far as Egypt, thus including all the country of the Philistines.

PHILISTUS, a celebrated historian of Syracuse, who was an active partisan of Dionysius the elder, and was by him made governor of the citadel, B. C. 406. Having dared to marry a relation of the tyrant without his knowledge, he was compelled to fly, and took refuge in the city Adria, in the north of Italy, where he employed himself in writing the history of his native island. Philistus tried to procure his recall, by representing the government of Dionysius in a very favourable light; but the prince refused to listen to his entreaties; and it was not till the accession of Dionysius the younger that he returned to his native country. It is said that the political party in Syracuse which supported despotic principles were afraid of the influence that Plato might have over the mind of Dionysius; and as Philistus had always been a strenuous assertor of arbitrary power, and was, besides, possessed of considerable talents, it was thought that he might have been made use of to counteract the effects of Plato's eloquence. Philistus was killed, B. C. 356, by the Syracusans. He wrote a history of Sicily, the first part of which was contained in seven books, and extended over a period of eight hundred years, terminating with the siege of Agrigentum, B. C. 406. The second part contained the history of the elder Dionysius to B. C. 368, and he gave, in two books, the reign of Dionysius the younger till B. C. 363.

PHILO, an ancient Greek writer, descended of a noble family amongst the Jews, flourished at Alexandria during the reign of Caligula. He was the chief of an embassy sent to Rome about the year forty-two, to plead the cause of the Jews against Apion, who had been sent by the Alexandrians to charge them with neglecting the honours due to Cæsar. Caligula, however, would not allow him to speak, and behaved to him in such a manner that Philo was in considerable danger of losing his life. Others, again, tell us that he was heard, but that his demands were refused. He afterwards went to Rome in the reign of Claudius, and both Eusebius and Jerome inform us that he became acquainted with St Peter, with whom he lived on terms of friendship. Photius adds, that he became a Christian, but afterwards, from some motive of resentment, recanted. All this, however, is uncertain, because the precise period at which St Peter visited Rome has not been ascertained.

Philo was educated at Alexandria, and made very great progress in eloquence and in philosophy. After the fashion of the time, he cultivated, like many of his nation and faith, the philosophy of Plato, whose principles he so thoroughly imbibed, and whose manner he so well imitated, that it became a common saying, *Aut Plato philonizat, aut Philo platonizat.* Josephus describes him as a man "eminent on all accounts;" and Eusebius represents him as "copious in speech, rich in sentiments, and sublime in the knowledge of Holy Writ." He was, however, so much immersed in philosophy, particularly the Platonic, that he neglected the Hebrew language, and also the rites and customs of his own people. Scaliger alleges, that Philo knew no more of Hebrew and Syriac than a Gaul or a Scythian. Grotius is of opinion that he is not fully to be depended on in what relates to the manners of the Hebrews; and Cudworth declares that, though a Jew by nation, he was yet very ignorant of Jewish customs. But Fabricius thinks differently; for although he admits the inadvertencies and errors of Philo in regard to these matters, he does not discover sufficient reason to justify charging so illustrious a doctor of the law with ignorance. He allows, however, that Philo's passion for philosophy had made him more than half a Pagan. It led him to interpret the whole of the law and the prophets upon Platonic ideas, and to admit nothing as truly interpreted which was not agreeable to the principles of the Academy. Besides, he turned every thing into allegory, and deduced the darkest meanings from the plainest words. This pernicious practice Origen is known to have imitated, and thus exposed himself to the scoffs of Celsus and of Porphyry. Philo's writings abound with high and mystical, as well as subtile, far-fetched, and abstracted notions; and indeed the doctrines of Plato and Moses are so promiscuously blended, that it is not easy to assign to each his peculiar prerogatives. In his works, however, there are certainly many excellent things. Though he is continually platonizing and allegorizing the Scriptures, he abounds with fine sentiments and lessons of morality; and his morals are rather the morals of a Christian than those of a Jew. History, as well as his own writings, give us every reason to believe that he was a man of great prudence, constancy, and virtue.

His works were first published in Greek by Turnebus, at Paris, 1552; and to these a Latin translation, executed by Gelenius, was afterwards added. The Paris edition of 1640, in folio, is the best that was published for a century; a circumstance which led Cotelerius to observe, that Philo was an author who deserved to have a better text and a better version. This, however, was accomplished, in 1742, when a handsome edition of his works was published at London, by Dr Mangey, in two vols. folio. In 1797, Jacob Bryant published the Sentiments of Philo Judæus concerning the *Logos* or Word, in order to prove that Philo borrowed his sentiments and expressions relative to the second person of the adorable Trinity from the apostles. But it is to be observed here, that Philo's authority had repeatedly before been founded on by various writers in favour of the fundamental principle of the existence of a Divine Unity in a Trinity of Persons; particularly by Dr Allix in his Judgment of the Jewish Church, 1699, and also by Mr Whitaker in his Origin of Arianism Disclosed, 1791.

Philo, a native of Byblos, in Syria, is believed by Vossius to have been born in the tenth year of the reign of Tiberius, A. D. 24, and to have lived to the times of the Emperor Hadrian, who succeeded to the empire A. D. 117. He gained considerable reputation as a writer both of history and grammar; but his name has come down to us chiefly as the translator of a history which Sanchoniathon had written in the Phœnician language. Eusebius has preserved several fragments of the preface of Philo, and also of this history. This fragment has called forth the ingenuity of many modern writers, but more particularly of Mr Dodwell, who has written a very learned dissertation on the subject. Fourmont also makes it the text of a work which he entitled *Réflexions Critiques sur les Histoires des anciens Peuples*, two vols. 4to.

Philo, a celebrated writer on mechanics, was a native of Byzantium, and flourished in the year 160, being the contemporary of Ctesibius and Hero. He was the author of a work entitled *Poliorcetica*, on the method of attacking and defending towns, of which the fourth and fifth books have been preserved. The first treats of the manner of preparing arrows, balistæ, catapultæ, and other warlike engines. Amongst other inventions, he mentions a machine of Ctesibius which discharged weapons by means of compressed air, upon the same principle, no doubt, as our air-gun. In the second book he treats of the manner of fortifying and provisioning cities, and, amongst other things, recommends that the provisions and water be poisoned if there be danger of the place falling into the hands of an enemy. This work has been published, with a Latin translation, in a collection entitled *Veterum Mathematicorum Opera*, Par. 1693. The invention of the air-gun has been treated of by Alb.-Louis Meister, *De Catapulta polybola Commentatio qua locus Philonis Mechanici, in libro iv. de telorum constructione certans illustratur*, Göttingen, 1768. There is another little work attributed to Philo, entitled *De septem Orbis Spectaculis*, part of the sixth chapter of which, and the whole of the seventh, are lost. It has been published, with a Latin translation, and many learned notes, by J. C. Orelli, Leipzig, 1816, 8vo.

PHILOLAUS, of Crotona, was a celebrated philosopher of antiquity, of the school of Pythagoras, to whom that philosopher's *Golden Verses* have been ascribed. As he made the heavens the principal object of contemplation, it has been idly supposed that he was the author of the true system of the world, which Copernicus afterwards revived. This notion led Bullialdus to place the name of Philolaus at the head of two works written expressly to illustrate and defend that system.

PHILOLOGY.

Definition.

Philology is compounded of the two Greek words φιλος and λογος and imports the desire of investigating the properties and affections of *words*. The sages of Greece were, in the most ancient times, denominated σοφοι, that is, wise men. Pythagorus renounced this pompous appellation, and assumed the more humble title of φιλοσοφος, that is, a lover of wise men. The learned Greeks were afterwards called philosophers; and in process of time, in imitation of this epithet, the word *philologer* was adopted, to import a man deeply versed in languages, etymology, and antiquities. Hence the term *philology*, which denotes the science that we propose briefly to discuss in the following article.

Objects and uses of philology.

Although philology, in its original import, denoted only the study of words and language, it gradually acquired a much more extensive, and at the same time a much more useful, as well as more exalted, signification. It comprehended the study of grammar, criticism, etymology, the interpretation of ancient authors, antiquities; and, in a word, every thing relating to ancient manners, laws, religion, government, and language. In this enlarged sense of the word, philology becomes a science of the greatest utility; it opens a wide field of intellectual investigation, and indeed calls for a more intense exertion of industry, and multifarious erudition, than most of those departments of literature which custom has dignified with more high-sounding names. It is indeed apparent, that, without the aid of philological studies, it is impossible upon many occasions, to develope the origin of nations; to trace their primary frame and constitution; to discover their manners, customs, laws, religion, government, language, progress in arts and arms; or to learn by what men and what measures the most celebrated states of antiquity rose into grandeur and consideration. The study of history, so eminently useful to the legislator, the divine, the military man, the lawyer, the philosopher, and the private gentleman who wishes to employ his learned leisure in a manner honourable and improving to himself, and useful to his country, will contribute very little towards enlightening the mind without the aid of philological researches. For these reasons we shall endeavour to explain the various branches of that useful science as fully, and intelligibly as the nature of the present undertaking will permit.

Object of this article.

Most of the branches of philology have already been treated of under the heads of GRAMMAR and LANGUAGE. But there still remains one part, which has either been slightly touched upon, or totally omitted, under the foregoing topics; we mean, the nature and complexion of most of the oriental tongues, as also some of the radical dialects of the languages of the west. As we would willingly gratify our readers of every description to the utmost of our power, we shall endeavour in this place to communicate to them as much information upon that subject as the extent of our reading, and the limits prescribed for a single article, will permit.

Before entering upon this subject, however, we must observe, that it is not our intention to fill our pages with a tedious, uninteresting, catalogue of barbarous languages, spoken by savage and inconsiderable tribes, of which little, or perhaps nothing, more is known than barely their names. Such an enumeration would swell the article without communicating one single new idea to the reader's antecedent stock. We shall therefore confine our inquiries to such languages as have been used by considerable states and societies, and which of consequence have acquired a high degree of celebrity in the regions of the east.

Variety of dialects before the deluge.

What was the antediluvian language, or whether it was divided into a variety of dialects as at this day, can only be determined by the rules of analogy; and these will lead us to believe, that whatever might have been the primitive language of mankind, if human nature was then constituted as it is at present, a great variety of dialects must of necessity have sprung up in the space of nearly two thousand years. If we adopt the Mosaic account of the antediluvian events, we must admit that for several ages the descendants of Cain lived separated from those of Seth. Their manner of life, their religious ceremonies, their laws, their form of government, were probably different, and these circumstances would of course produce a variety in their language. The posterity of Cain were an inventive race. They found out the arts of metallurgy, music, and some think of weaving; and in all probability many other things conducive to the ease and the accommodation of life were the produce of their ingenuity. A people of this character must have paid no small regard to their words and modes of expression. Wherever music is cultivated, language will naturally be improved and refined. When new inventions are introduced, a new race of words and phrases of necessity spring up, corresponding to the recent stock of ideas to be intimated. Besides, amongst an inventive race of people, new words would be continually fabricated, in order to supply the deficiencies of the primitive language, which was probably scanty in its vocabulary, and its phraseology unpolished. The Cainites, then, amongst their other improvements, cannot well be supposed to have neglected the cultivation of language.

Origin of writing.

Many conjectures have been hazarded both by ancient and modern authors respecting the origin of writing; an art which is nearly connected with that of speaking. According to Pliny,[1] "the Assyrian letters had always existed; some imagined that letters had been invented by the Egyptian Mercury; others ascribed the honour of the invention to the Syrians." The truth seems to be, that letters were an antediluvian invention, preserved amongst the Chaldeans or Assyrians, who were the immediate descendants of Noah, and inhabited those very regions in the neighbourhood of which the ark rested, and where that patriarch afterwards fixed his residence. The circumstance, we think, affords a strong presumption that the use of letters was known before the deluge, and transmitted to the Assyrians and Chaldeans by Noah their progenitor, or at least by their immediate ancestors of his family. If, then, the art of writing was an antediluvian invention, we think that in all probability it originated amongst the posterity of Cain.

The descendants of Seth, according to the oriental tradition, were chiefly addicted to agriculture and the tending of cattle. They devoted a great part of their time to the exercises of piety and devotion. From this circumstance they came to be distinguished by the title of the *sons of God.*[2]

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[1] *Nat. Hist.* lib. vii. cap. 56.

[2] From this passage (Gen. vi. 2.) misunderstood, originated the absurd idea of the connection between angels and mortal women. (See Josephus, *Antiq. Jud.* lib. i. cap. 4. and Eusebius, *Chron.* lib. i.) The Fathers of the church, almost without exception, adopted this foolish notion. (See also *Philo-Jud.* p. 198, edit. Turn. Paris, 1552.)

According to this description, the Sethites were a simple,[1] unimproved race of people till they mingled with the race of Cain; after which period they at once adopted the improvements and the vices of that wicked family.

It is not, probable, however, that all the descendants of Seth, without exception, mingled with the Cainites. That family of which Noah was descended had not incorporated with the race of Cain. According to the sacred historian, it was lineally descended from Seth, and had preserved the worship of the true God, when, it is probable, the greatest part of mankind had apostatised and become idolaters.[2] Along with the true religion, the progenitors of Noah had preserved that simplicity of manners and equability of character which had distinguished their remote ancestors. Agriculture and the rearing of cattle had been their favourite occupations. Accordingly we learn, that the patriarch Noah, immediately after the deluge, became a husbandman, and "planted a vineyard." The chosen patriarchs, who doubtless imitated their pious ancestors, were shepherds, and employed in the rearing and tending of cattle. Indeed there are strong presumptions that the Chaldeans, Assyrians, Syrians, Canaanites, and Arabians, in the earliest ages followed the same profession.

From this deduction, we imagine, it is at least probable, that the ancestors of Noah persisted in the observance of the same simplicity of manners which had been handed down from Adam to Seth, and from him to Enoch, Methuselah, Lamech, and from this last to Noah himself. According both to scripture and tradition, innovations were the province of the Cainites, whilst the descendants of Seth adhered to the primitive and truly patriarchal institutions.

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If these premises are allowed the merit of probability, we may justly infer that the language of Noah, whatever it was, differed very little from that of Adam;[3] and that if it is possible to ascertain the language of the former, that of the latter will of course be discovered. We shall then proceed to throw together a few observations relating to the language of Noah, and leave our readers to judge for themselves. We believe it will be superfluous to suggest, that our intention in the course of this deduction is, if possible, to trace the origin and antiquity of the Hebrew tongue; and to try to discover whether that language, or any of its sister dialects, may claim the honour of being the original language of mankind.

Whatever may have been the dialect of Noah and his family, that same dialect, according to the Mosaic account, must have obtained, without any alteration, until the era of the building of the tower of Babel. Upon this occasion a dreadful convulsion took place; the language of mankind was confounded, and men were scattered abroad upon the face of all the earth.

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How far this catastrophe[4] extended, it is not the business of the present inquiry to determine. But one thing is certain beyond all controversy, namely, that the languages of all the nations which settled near the centre of population were but slightly affected by its influence. A very judicious writer has observed,[5] that three thousand years afterwards, the inhabitants of those countries exhibited a very strong resemblance of cognation, "in their *language*, manner of living, and the lineaments of their bodies." At the same time he observes, that "the resemblance in all those particulars was most remarkable amongst the inhabitants of Mesopotamia." This observation, with respect to language, will, we doubt not, be vouched by every one of our readers who has acquired even a superficial knowledge of the languages current in those countries at a very early period.

It appears, then, that the languages of the Armenians, Syrians, Assyrians, Arabians, and probably of the Chanaanim, did not suffer materially by the confusion of tongues. This observation may, we imagine, be extended to many of the dialects spoken by the people who settled in those countries not far distant from the region where the sacred historian has fixed the original seat of mankind after the deluge.[6] The inference then is, that if Noah and his family spoke the original language of Adam, as they most probably did, the judgment which effected the confusion of tongues did not produce any considerable alteration in the language of such of the descendants of Noah as settled near the region where that patriarch had fixed his residence after he quitted the ark.

A part only of mankind engaged in building the tower.

But supposing the changes of language produced by the catastrophe at the building of the tower as considerable as has ever been imagined, it does not, after all, appear certain, that all mankind, without exception, were engaged in this impious project. If this assertion should be well-founded, the consequence would be, that there was a chosen race who did not engage in that enterprise. If there was such a family, society, or body of men, it must follow, that this family, society, or body of men, retained the language of its great ancestor without change or variation. That such a family did actually exist, is highly probable, for the following reasons.

1. We think there is reason to believe that Ham, upon the heavy curse denounced upon him by his father,[7] retired from his brethren, and fixed his residence elsewhere. Accordingly we find his descendants scattered far and wide, at a very great distance from the Gordyæan mountains, where the ark is generally supposed to have rested immediately after the Flood. Some of them we find in Chaldæa, others in Arabia Felix, others in Ethiopia,[8] others in Canaan, and others in Egypt; and, finally, multitudes were scattered over all the coast of Africa. Between these countries were planted many colonies of Shemites, in Elam, Assyria, Syria, Arabia, &c. We find, at the same time, the descendants of Shem and Japhet settled, in a great degree, contiguous to each other. This dispersion of the Hamites, irregular as it is, can scarcely, we think, have been accidental; it must have been owing to some uncommon cause, and none seems more probable than that assigned above. If, then, the descendants of Ham separated early, and took different routes, as from their posterior situations it appears they did, they could not all be present at the building of the tower.

The descendants of Shem not concerned in this project.

2. It is not probable that the descendants of Shem were engaged in this undertaking, since we find that they were not scattered abroad upon the face of all the earth. The children of Shem were Elam, Ashur, Arphaxad, Lud, and Aram.[9] Elam settled near the mouth of the river Tigris, in the country which, by the Gentile writers, was called *Ely-*

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[1] The orientals, however, affirm, that Seth, whom they call *Edris*, was the inventor of astronomy.

[2] We think it highly probable that idolatry was established before the deluge, because it prevailed almost immediately after that catastrophe. See POLYTHEISM.

[3] For some conjectures respecting the language first communicated to Adam, see the article on LANGUAGE, and also Schuckford's *Connect.* vol. i. lib. ii. p. 111. *et seq.*

[4] Josephus and the Fathers of the church tell us, that the number of languages produced by the confusion of tongues was seventy-two; but this is a mere rabbinical legend.

[5] Strabo.

[6] The language of the Medes, Persians, Phœnicians, and Egyptians, very much resembled each other in their original complexion; and all had a strong affinity to the Hebrew, Chaldaic, Syriac, &c. (See Walton's *Prolegomena*, Gale's *Court of the Gentiles*, vol. i. lib. i. ch. 11, p. 70, *et seq.*; Bochart, *Phaleg* and *Chanaan*, pass.) To these we may add the Greek language, as will appear more fully below.

[7] Gen. ix. 25.

[8] Josephus informs us, that all the nations of Asia called the Ethiopians *Cushim*, (lib. i. cap. 7.)

[9] Gen. x. 22.

mais. Above him, on the same river, lay the demesne of Ashur, on the western side. In like manner, upon the same river, above him, was situated Aram, who possessed the country of Aramea; and opposite to him was Arphaxad, or Arbaces, or Arbaches, whose country was denominated *Arphachites.* Lud, as some think, settled in Lydia, amongst the sons of Japhet; but this opinion seems to be without foundation.[1] Here, then, there is a dispersion, but such as must have originated from the nature of the thing. The four, or rather the five brothers, all settled contiguously, without being scattered abroad upon the face of the whole earth. Besides, there was no confusion of language amongst these tribes, who continued to use one and the same tongue through many succeeding generations.

From these circumstances it appears, that the posterity of Shem were not involved in the guilt of the builders of the tower, and consequently did not undergo their punishment. If then the language of the Shemites was not confounded upon the erection of the tower, the presumption is, that they retained the language of Noah, which, in all probability, was that of Adam. Some dialectical differences would in process of time creep in, but the radical fabric of the language would remain unaltered.

Language of Adam preserved down to Abraham.

3. The posterity of Shem appear in general to have followed the pastoral life. They imitated the style of living adopted by the antediluvian posterity of Seth. No sooner had Noah descended from the ark, than he became *Ish ha Adamah*, "a man of the earth," that is, a husbandman, and planted a vineyard. We find that some ages afterwards, Laban the Syrian had flocks and herds; and that the chief wealth of the patriarch Abraham and his children consisted in their flocks and herds. Even his Gentile descendants, the Ishmaelites and Midianites, seem to have followed the same occupation. But people of this profession are seldom given to changes. Their wants are few, and consequently they are under few or no temptations to deviate from the beaten track. This circumstance renders it probable that the language of Noah, the same with that of Adam, was preserved with little variation amongst the descendants of Arphaxad down to Abraham.

We have observed above, that Ham, upon the curse denounced against him by his father, very probably left the society of his other brothers, and emigrated elsewhere, as Cain had done in the antediluvian world. There is a tradition still current in the east, and which was adopted by many of the Christian fathers,[2] that Noah, in the nine hundredth and thirtieth year of his life, by divine appointment, did, in the most formal manner, divide the whole terraqueous globe amongst his three sons, obliging them that they would take an oath to stand by the decision. Upon this happened a migration at the birth of Peleg, that is, about three centuries after the Flood. It is affirmed that Nimrod the arch rebel disregarded this partition, and encroached upon the territory of Ashur, which occasioned the first war after the deluge.

The Greeks had acquired some idea of this partition, which they supposed to have been between Jupiter, Neptune, and Pluto.[3] Plato seems to have heard of it;[4] "for," says he, "the gods of old obtained the dominion of the whole earth, according to their different allotments; and this was effected without any contention, for they took possession of their several provinces in a fair and amicable way, by lot." Josephus,[5] in his account of the dispersion of mankind, plainly insinuates a divine destination; and Philo-Judæus[6] was of the same opinion before him.

In consequence of this arrangement, the sons of Shem possessed themselves of the countries mentioned in the preceding pages; the posterity of Japhet had spread themselves towards the north and west; but the Hamites, who had separated from their brethren in consequence of the curse, not choosing to retire to their quarters, which were indeed very distant from the place where the ark rested,[7] seized upon the land of Canaan. Perhaps, too, it might be suggested by some malicious spirits, that the aged patriarch was dealing partially when he assigned to Ham and his posterity a quarter of the world to inhabit, not only remote from the centre of population, but likewise sequestered from the rest of mankind.[8]

But be this as it may, the children of Ham removed eastward, and at length descending from the Carduchean or Gordyæan mountains, directed their course westward, and arrived at the plains of Shinar, which had been possessed by the Ashurim ever since the era of the first migration at the birth of Peleg. The sacred historian informs us, that the whole earth was of one language and of one speech; that in journeying from the east, they lighted upon the plain of Shinar, and dwelt there. In this passage we find no particular people specified; but as we find Nimrod, one of the descendants of Ham, settled in that country, we may be sure that they were the offspring of that patriarch. It would not, we think, be easy to assign a reason how one branch of the family of Ham came to plant itself in the midst of the sons of Shem by any other means but by violence.

The tower of Babel built by the children of Ham.

It is indeed generally supposed, that Nimrod, at the head of a body of the children of Ham, made war upon Ashur, and drove him out of the country of Shinar, and there laid the foundation of that kingdom, the beginning of which was Babel; that this chief, supported by all the Cushites, and a great number of apostates from the families of Shem and Japhet who had joined him, refused to submit to the divine ordinance by the mouth of Noah, with respect to the partition of the earth; and that he and his adherents were the people who erected the celebrated tower, in consequence of a resolution which they had formed to keep together, without repairing to the quarters assigned them by the determination of Heaven. This was the crime which brought down the judgment of the Almighty upon them, by which they were scattered abroad upon the face of all the earth. The main body of the children of Shem and Japhet were not engaged in this impious undertaking; their language, therefore, was not confounded, nor were they themselves scattered abroad. Their habitations were contiguous, those of the Shemites towards the centre of Asia; the dwellings of Japhet were extended towards the north and north-west; and the languages of both these families continued for many ages without the least variation, except what time, climate, laws, religion, new inventions, arts, sciences, and commerce, will produce in every tongue in a succession of years.

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[1] The ancient name of Lydia was Mæonia. (See Strabo *Casaub.* lib. xiii. p. 586, chap. 7. *Rhod.* 577.) The Lydians were celebrated for inventing games; on which account they were nicknamed by the Æolian Greeks Λυδοι, *Lydi* or *Ludi*, from the Hebrew word LUTZ, *ludere, illudere, deridere.* We find (Ezek. xxvii. 10.) the men of Elam and the men of Lud joined in the defence of Tyre; which seems to intimate, that the Elamites and Ludim were neighbours. If this was actually the case, then Lud settled in the same quarter with his brothers.

[2] Epiphan. (vol. i. p. 5. *ibid.* p. 709.) where our learned readers will observe some palpable errors about *Rhinocorura*, &c. (Eusebius, *Chron.* p. 10. Syncellus, p. 89. Cedrenus *Chron. Pasch.* &c.)

[3] Callimach. *Hym.* Hom. *Iliad*, lib. xv.

[4] Critias, vol. iii. p. 109. *Serr.* Apollodorus mentions a time when the gods respectively selected particular cities and regions, which they were to take under their peculiar protection.

[5] *Antiq. Jud.* lib. i. c. 5.

[6] Lib. x. p. 236. Turn. Paris, 1552. We have a plain allusion to this distribution in Deuteronomy (xxxii. 7.) "When the Most High divided to the nations their inheritance, when he separated the sons of Adam, he set the bounds of the people, according to the number of the children of Israel; for the Lord's portion is his people; Jacob is the lot of his inheritance." From this passage it appears, that the whole was arranged by the appointment of God, and that the land of Canaan was expressly reserved for the children of Israel. St. Paul (Acts xvii. 16.) speaks of this divine arrangement, "God made of one blood all nations of men, that dwell on the face of the earth; and determined the bounds of their habitation."

[7] The ark, according to the most probable accounts, rested upon Mount Ararat in Armenia.

[8] We think it by no means improbable that Noah, well knowing the wickedness of the family of Ham, and especially their inclination to the idolatry of the antediluvians, might actually intend to separate them from the rest of mankind.

The general opinion then was, that none but the progeny of Ham and their associates were present at the building of the tower, and that they only suffered by the judgment consequent upon that attempt.[1] There are even amongst the pagans some allusions to the division of the world amongst the three sons of Noah. Many of the learned have imagined that this patriarch was Saturn, and that his three sons were Jupiter, Neptune, and Pluto, as has been observed above.

Berosus, in his history of the Babylonians, informs us, that Noah, at the foot of Mount Baris or Luban, where the ark rested, gave his children their last instructions, and then vanished out of sight.[2] It is now generally believed that the Xisuthrus of Berosus was Noah. Eupolemus, another heathen writer, tells us, "that the city Babel was first founded, and afterwards the celebrated tower; both which were built by some of those people who escaped the deluge. They were the same with those who in after times were exhibited under the name of *giants*. The tower was at length ruined by the hand of the Almighty, and those giants were scattered over the whole earth."[3] This quotation plainly intimates, that according to the opinion of the author, only the rascally mob of the Hamites, and their apostate associates, were engaged in this daring enterprise.

Indeed, it can never be supposed that Shem, if he was alive at that period, as he certainly was, would co-operate in such an absurd and impious undertaking. That devout patriarch, we think, would rather employ his influence and authority to divert his descendants from an attempt which he knew was undertaken in contradiction to an express ordinance of Heaven; and it is surely very improbable that Elam, Ashur, Arphaxad, and Aram, would join that impious confederacy, in opposition to the remonstrances of their father.

The building of the tower, according to the most probable chronology, was undertaken at a period so late, that *all mankind* could not possibly have concurred in the enterprise.

Many of the fathers were of opinion, that Noah settled in Armenia, the country where the ark rested; and that his descendants did not leave that region for five generations,[4] or during the space of 659 years. By this period the human race must have been so amazingly multiplied, that the plains of Shinar could not have contained them. According to the Samaritan Pentateuch, and the Septuagint version, Peleg was born in the 134th year of his father Eber. Even admitting the vulgar opinion, that the tower had begun to be built, and the dispersion consequent upon that event must have taken place at this era, the human race would have been by much too numerous to have universally concurred in one common design.

From these circumstances, we hope it appears that the whole mass of mankind was not engaged in building the tower of Babel; that the language of all the human race was not confounded upon that occasion; and that the dispersion reached only to a combination of Hamites, and of the most profligate part of the two other families, who had joined their wicked confederacy.

The original language preserved in the other two families.

We have pursued this argument to considerable length, because some have inferred, from the difference in languages existing at this day, that mankind cannot have sprung from two individuals; because from the connection still existing amongst languages, some have been bold enough to question the fact, though plainly recorded in sacred history; and lastly, because we imagine that some of our readers, who do not pretend to peruse the writings of the learned, may be gratified by seeing the various opinions respecting the confusion of tongues, and the dispersion of mankind, collected into one mass, equally brief, we hope, and intelligible. And this view of these opinions, with the foundations on which they respectively rest, we think may suffice to prove, that the language of Noah was for some ages preserved, unmixed, amongst the descendants of both Shem and Japhet.

To gratify still further such of our curious readers as may not have access to more ample information, we shall in this place exhibit a brief detail of the circumstances which attended this fatal attempt. The people engaged in it have been held up as a profligate race. The Almighty himself denominates them "*the children of men*," which is the very appellation by which the antediluvian sinners were characterised; *the sons of God saw the daughters of men*, &c. Their design in raising this edifice was, "*to make them a name, and to prevent their being scattered abroad upon the face of the whole earth*."[5]

Whatever resolution the rest of mankind might take, they had determined to maintain themselves on that spot. The tower was intended as a centre of union, and perhaps as a fortress of defence. Such a stupendous fabric, they imagined, would immortalize their memory, and transmit the name of their confederacy with distinction to future ages.[6] The design plainly intimates, that there was only a party concerned in the undertaking, since, had all mankind been engaged in it, the purpose would have been foolish and futile. Again, they intended, by making themselves *a name*, to prevent their being scattered abroad upon the face of the earth. This was an act of rebellion in direct contradiction to the divine appointment, which constituted their crime, and brought down the judgment of Heaven upon their guilty heads. But the consequence of the confusion of languages was, that the projectors left off building, and were actually scattered abroad, contrary to their intention.

Pagan tradition concerning Babel.

Abydenus, in his Assyrian Annals, records, that the tower was carried up to heaven; but that the gods ruined it by storms and whirlwinds, and overthrew it upon the heads of those who were employed in the work, and that the ruins of it were called *Babylon*.[7] Before this there was but one language subsisting amongst men; but now there arose πολυθρηφωνη, *a manifold speech;* and he adds, that a "war soon after broke out between Titan[1] and Kronos."[2] The Sybilline oracles give much the same account of this early and important transaction.

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[1] Some learned men have imagined that this confusion of language, was only a temporary failure of pronunciation, which was afterwards removed. This they are led to conclude, from the agreement of the languages of these people in after times.

[2] Euseb. *Chron.*

[3] Euseb. *Præp. Evangel.* lib. ix.

[4] Epiph. *Hæres.* lib. i.

[5] Gen. chap. xi.

[6] Many foolish and absurd notions have been entertained concerning this structure. Some have imagined that they meant to take shelter there in case of a second deluge; others, that it was intended for idolatrous purposes; others, that it was to be employed as an observatory. Its dimensions have likewise been most extravagantly magnified. Indeed Strabo, lib. 16, mentions a tower of immense size remaining at Babylon in his time, the dimensions of which were a stadium every way. This, however, seems to have been the remains of the temple of Bel or Belus.

[7] See the Greek original of this quotation, Euseb. *Chron.* lib. i. p. 73.

Justin[3] informs us, that the Phœnicians who built Tyre, were driven from Assyria by an earthquake. These Phœnicians were the descendants of Mizraim the youngest son of Ham; they were, we think, confederates in building the tower, and were driven away by the catastrophe that ensued. Many other allusions to the dispersion of this branch of the family occur in pagan authors, but the limits to be observed in an inquiry of this nature oblige us to omit them, on the whole, we think it probable that the country of Shinar lay desolate for some time after this revolution; for the dread of the judgment inflicted upon the original inhabitants would deter men from settling in that inauspicious region. At last, however, a new colony arrived, and Babel, or Babylon, became the capital of a flourishing kingdom.

Our readers, we believe, will expect that we should say something of Nimrod the mighty hunter, who is generally thought to have been deeply concerned in the transactions of this period. According to most authors, both ancient and modern, this patriarch was the leader of the confederates who erected the tower, and the chief instigator to that enterprise. But if the tower was built at the birth of Pheleg, according to the Hebrew computation, that chief was either a child,[4] or rather not born at that period.[5] The Seventy have pronounced him a giant, as well as a huntsman. They have translated the Hebrew word *Gebur*, which generally signifies strong, mighty, by the word γιγας, giant; an idea which we imagine those translators borrowed from the Greeks. The antediluvian giants are called *Nephelim* and *Rephaim*, but never *Geburim*. The Rabbinical writers, who justly hated the Babylonians, readily adopted this idea;[6] and the Fathers of the church, and the Byzantine historians, have universally followed them. He has been called *Nimrod*, *Nebrod*, *Nymbroth*, *Nebroth*, and *Nebris*. Not a few have made him the first Bacchus, and compounded his name of *Bar*, a son, and *Cush*, that is the son of *Cush*. Some have imagined that he was the Orion of the pagans, whose shade is so nobly described by Homer.[7] But the etymology of this last name implies something honourable, and very unsuitable to the idea of the tyrant Nimrod.[8] It must be observed, however, that we find nothing in Scripture to warrant the supposition of his having been a tyrant; so far from it, that some have deemed him a benefactor to mankind.[9]

The beginning of this prince's kingdom was Babel. Eusebius gives us first[10] a catalogue of six kings of the Chaldeans, and then another of five kings of Arabian extraction, who reigned in Chaldæa after them. This might naturally enough happen, since it appears that the inhabitants of those parts of Arabia which are adjacent to Chaldæa were actually Cushites, of the same family with the Babylonians.[11]

The Cushites, however, were at last subdued, perhaps partly expelled Chaldæa by the *Chasiaim*, who probably claimed that territory as the patrimony of their progenitors. That the Chasidim were neither Cushites, nor indeed Hamites, is obvious from the name. The Hebrews, and indeed all the Orientals,[12] denominated both the people who inhabited Arabia, *Cushim*, and also the Ethiopians who sprung from the last-mentioned people. Had the later inhabitants of Chaldæa been the descendants of Cush, the Jewish writers would have called them Cushim. We find they called the Phœnicians *Chanaanim*, the Syrians *Aramim*, the Egyptians *Mizraim*, the Greeks *Jonim*, and so on. The Chasidim, therefore, or modern inhabitants of Chaldæa, were positively descended of one Chesed or Chased; but who this family-chief was, it is not easy to determine. The only person of that name whom we meet with in early times, is the fourth son of Nahor,[13] the brother of Abraham; and some have been of opinion that the Chaldeans were the progeny of this same Chesed. This appears to us highly probable, because both Abram and Nahor were[14] natives of Ur of the Chasidim. The former, we know, in consequence of the divine command, removed to Haran, afterwards *Charræ;* but the latter remained in Ur, where his family multiplied, and, in process of time, became masters of the country which they called the land of the Chasidim, from Chesed or Chased, the name of their ancestor. This account is the more probable, as we find the other branches of Nahor's family settled in the same neighbourhood.[15]

Origin of the name *Chaldæi.*

How the Greeks came to denominate these people Χαλδαιοι, *Chaldæi*, is a question rather difficult to be resolved; but we know that they always affected to distinguish people and places by names derived from their own language. They knew a rugged, erratic nation[16] on the banks of the Thermodoon, in the territory of Pontus, bordering on Armenia the Less. These, in ancient times, were called *Alybes* or *Calybes*, because they were much employed in forging and polishing iron. Their neighbours, at length, gave them the name of *Chald* or *Caled*, which imports, in the Armenian dialect, fierce, hardy, robust. This title the Greeks adopted, and out of it formed the word Χαλδαιοι, or Chaldeans.

The Mosaic history informs us,[17] that Ashur went out of the land of Shinar, and built Nineveh and several other considerable cities. One of the successors of Ashur was the celebrated Ninus, who first broke the peace of the world,[1] made war upon his neighbours, and obliged them by force of arms to become his subjects, and pay tribute. Some authors make him the immediate successor of Ashur, and the builder of Nineveh. This we think is not probable; and Eusebius, as we have observed above, gives a list of six Arabian princes who reigned in Babylon. These we take to have been the immediate successors of Nimrod, called *Arabians*, because these people were Cushites. Ninus might be reputed the first king of the Assyrians, because he figured beyond his predecessors; and he might pass for the builder of Nineveh, because he greatly enlarged and beautified that city. We therefore imagine, that Ninus was the fifth or sixth in succession after Ashur.

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[1] This war was probably carried on between the leaders of the Hamites and Ashur upon their invasion.

[2] Theoph. *ad Antol.* lib. ii. page 107, ed. Paris, 1636.

[3] *Philip.* lib. xviii. cap. 3.

[4] Bochart, *Phaleg.* lib. i. cap. 10.

[5] Gen. x. 8, 9. "This man began to be a *giant* upon the earth; he was the giant hunter before the Lord God.—As Nymbrod the *giant* hunter before the Lord."

[6] See Mr. Bryant's *Analysis*, vol. iii. p. 38, *et seq.*

[7] *Odys.* lib. i. verse 571.

[8] Orion is compounded of the Hebrew *Or*, "light," and *ion*, "one of the names of the sun;" and Orion was probably one of the names of that luminary.

[9] See Shuckford's *Connect.* vol. i. lib. 3. p. 179, 180. Also the authors of the *Univer. Hist.* vol. i.

[10] *Chron.* lib. i. p. 14.

[11] Gen. x. Ezek. xxvii.

[12] Joseph. *Ant.* lib. i. cap. 6.

[13] Gen. xxii. 22.

[14] Gen. xi. 28.

[15] Huz gave name to the country of Job; Elihu, one of Job's friends, was a Buzite of the kindred of Ram or Aram, another of the sons of Nahor. Aram, whose posterity planted Syria Cava, was the grandson of Nahor by Kemuel. Hence it appears probable that Job himself was a descendant of Nahor by Huz his first born.

[16] See Eustat. *in Dion. Perieg.* v. 768. Strabo, lib. xii. p. 543. Casaub. As the Chalybes were famous for manufacturing iron, so were they celebrated for making the choicest pieces of armour. They excelled in making κλιϐανοι, or coats of mail, or brigandines, used by the bravest of the Persian horsemen. Bochart (*Phaleg.* lib. iii. cap. 12 and 13) has proved that the word *Cheliba* signifies "scales of brass or steel." From the word *Cheliba*, the Greeks formed their Χαλυϐεις, *Chalybes.* Xenophon (*Cyrop.* lib. iii. p. 43, Steph.) represents the Chaldeans, who inhabited a mountainous country bordering upon Armenia, as a very fierce and warlike people. In page 107, we have an example of their rapacious character; and in lib. iv. p. 192, Hen. Steph. we have an account of their bravery and of their arms. Another instance of their rapacity occurs in their plundering the cattle of Job.

[17] A dispute has arisen about the sense of verse 10, chap. x. "Out of that land went forth Ashur, and builded Nineveh." Some approve our translation, which we think is just; others, considering that the inspired writer had been speaking of Nimrod and the beginning of his kingdom, are of opinion that it should be translated, "And out of this land *He.* (that is Nimrod,) went into Ashur and builded Nineveh." This they make a military expedition, and a violent irruption into the territory of Ashur.

Ninus, according to Diodorus Siculus,[2] made an alliance with Ariæus king of the Arabians, and conquered the Babylonians. This event, in our opinion, put an end to the empire of the Hamites or Cushim in Shinar or Babylonia. The author observes, that the Babylon which figured afterwards did not then exist. This fact is confirmed by the prophet Isaiah:[3] "Behold the land of the Chasidim; this people was not till Ashur founded it for them that dwell in the wilderness. They set up the towers thereof," &c. After Babylonia was subdued by the Assyrians under Ninus, the capital was either destroyed by that conqueror or deserted by the inhabitants. At length it was re-built by some one or other of the Assyrian monarchs, who collected the roving Chasidim, and obliged them to settle in the new city. These were subject to the Assyrian empire till the reign of Sardanapalus, when both the Medes and Babylonians rebelled against that effeminate prince.

The Chasidim were celebrated by all antiquity for their proficiency in astronomy, astrology, magic, and curious sciences. Ur or Orchoe was a kind of university for those branches of learning.[4] Such was their reputation in those studies, that over a great part of Asia and Europe a Chaldean and an astrologer were synonymous terms. These sciences, according to the tradition of the Orientals, had been invented by Seth, whom they called *Edris*; and had been cultivated by his descendants downwards to Noah, by whom they were transmitted to Shem, who conveyed them to Arphaxad and his posterity. To us it appears probable, that the religious sentiments transmitted from Noah through the line of Shem, were kept alive in the family of Arphaxad, and so handed down to the families of Serug, Nahor, Terah, Abraham, Nahor II. and Haran, &c. The Jewish rabbin, and all the Persian and Mahommedan writers, make Abraham contemporary with Nimrod; who, say they, persecuted him most cruelly for adhering to the true religion. That these two patriarchs were contemporary is very improbable, since Nimrod was the third generation after Noah, and Abraham the tenth. Abraham has been invested by the rabbinical writers with every department of learning. According to them, he transported from Charræ into Chanaan, astronomy, astrology, mathematics, geography, magic, alphabetical writing, &c.

gendary es concerning oraham.

After the Babylonish captivity, when the Jews were dispersed over all the east, and began to make *proselytes of the gate* amongst the Pagans, wonderful things were reported of Abraham with respect to his acquirements in human erudition, as well as his supereminence in virtue and piety. These legendary tales were believed by the proselytes, and by them retailed to their connections and acquaintances. But certainly the holy man was either not deeply versed in human sciences, or he did not deem them of importance enough to be communicated to his posterity; since the Jews are, on all hands, acknowledged to have made little progress in these improvements. To think of raising the fame of Abraham, by classing him with the philosophers, betrays an extreme defect in judgment. He is entitled to praise of a higher kind; for he excelled in piety, was the father of the faithful, the root of the Messiah, and the friend of God. Before these, all other titles vanish away. Such of our readers, however, as have leisure enough, and at the same time learning enough to enable them to consult the rabbinical legends, will be furnished with a full and ample detail of his imaginary exploits and adventures. Others, who are either not willing or not qualified to peruse the writings of the rabbin, may consult Dr. Hyde[5] and the authors of the Universal History,[6] where they will find materials sufficient to gratify their curiosity. We shall only observe, in addition to what we have already said, that the Persians, Chaldeans, and Arabians, pretended that their religion was that of Abraham; that honourable mention is made of him in the Koran; and that the name of Abraham or Ibrahim was celebrated all over the east.

In the progress of this disquisition, we have seen that the language of Noah was, in all probability, the same or nearly the same with that of Adam. Additions and improvements might be introduced, but still the radical stamina of the language remained unchanged. It has likewise, we hope, appeared, that the confusion of language at the building of the tower of Babel was only partial, and affected none but the rebellious crew of the race of Ham, and the apostate part of the families of Shem and Japhet. We have concluded, that the main body of the race of Shem, at least, were not dispersed nor was their language confounded; and that consequently the descendants of that patriarch continued to speak their paternal dialect or the uncorrupted language of Noah. To these arguments we may take the liberty to add another, which is, that in all probability the worship of the true God was preserved in the line of Arphaxad, after the generality of the other sects had lapsed into idolatry. Out of this family was taken Abraham, in whose line the true religion was to be preserved. Whether Abraham was an idolater when he dwelt in Chaldæa, the Scripture does not inform us, though it seems to be evident that his father was. One thing, however, is certain, namely, that Jehovah appeared to him, and pronounced a blessing upon him before he left Ur of the Chaldees.[7] This circumstance no doubt indicates, that the patriarch had made uncommon advances in piety and virtue, even prior to his emigration. The progenitors of his family had been distinguished by adhering to the true religion. About this time, however, they began to degenerate, and to adopt the Zabaism of their apostate neighbours. It was then that Abraham was commanded by Heaven to "leave his kindred and his father's house, and to travel into a land which was to be shown him." The Almighty intended that the true religion should be preserved in his line, and therefore removed him from a country and kindred, by the influence of whose bad example his religious principles might be endangered. His family had only of late apostatized; until that period they had preserved both the language and the religion of their venerable ancestors.

But however much Abraham might differ from the other

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[1] *Justin*, lib. i. cap. i. [2] Lib. ii. [3] Chap. xxiii. 13.

[4] Ur or Orchoe was situated between Nisibis and Corduena. (See Ammianus Marcellinus, *Expeditio Juliana*, lib. xv.) It lay not far from the river Tigris. Strabo, (lib. xvi. p. 739.) tells us that the Chaldean philosophers were divided into different sects; the Orcheni, the Borsipenni, and several others. Diodorus Siculus likewise, (lib. ii. p. 82. Steph.) gives an exact detail of the functions, profession, and establishment of the Chaldeans, to which we must refer our curious readers.

[5] *De Religione Veterum Persarum*, chap. ii. [6] Vol. i.

[7] Compare Gen. xii. 2 with Acts vii. 4.

The Hebrew and Chaldaic originally the same.

branches of his family in his religious sentiments, his language was certainly in unison with theirs. The consequence of this unquestionable position is, that the language which he carried with him into Chanaan was exactly the same with that of his family which he relinquished when he began his peregrinations. But if this be true, it will follow, that the language afterwards denominated Hebrew, and that of the Chasidim or Chaldeans, were originally one and the same. This position, we think, will not be controverted. There is then an end of the dispute concerning the original language of mankind. We have advanced some presumptive proofs in the preceding pages, that the language of Adam was transmitted to Noah, and that the dialect of the latter was preserved in the line of Arphaxad downwards to the family of Abraham; and it now appears that the Hebrew and Chaldaic were originally spoken by the same family, and of course essentially indentical, and were actually the first language upon earth, according to the Mosaic history. Numberless additions, alterations, improvements, we acknowledge, were introduced in the course of two thousand years; but still the original stamina of the language were unchanged. Our readers will please to observe that the Orientals are not a people given to change; and that this character, in the earliest ages, was still more prevalent than at present. This assertion, we presume, needs no proof.

In confirmation of these presumptive arguments, we may add the popular one which is commonly urged upon this occasion, namely, that the names of antediluvian persons and places mentioned by the sacred historian, are generally of Hebrew original, and significant in that language. Some of them, we acknowledge, are not so; but in this case it ought to be remembered, that a very small part of that language now exists, and that probably the radicals from which these words are descended are amongst the number of those which have long been lost.

SECT. I. THE HEBREW LANGUAGE.

Characteristics of the Hebrew language.

Having thus proved the priority of the Hebrew to every other language that has been spoken by men, we shall now proceed to consider its nature and genius; from which it will appear still more evidently to be an original language, neither improved nor debased by foreign idioms. The words of which it is composed are short, and admit of very little flexion. The names of places are descriptive of their nature, situation, accidental circumstances, &c. Its compounds are few, and inartificially joined together. In it we find few of those artificial affixes which distinguish the other cognate dialects; such as the Chaldean, Syrian, Arabian, and Phœnician. We find in it no traces of improvement from the age of Moses to the era of the Babylonian captivity. The age of David and Solomon was the golden period of the Hebrew tongue; and yet, in our opinion, it would puzzle a critic of the nicest acumen to discover much improvement even during that happy era. In fact, the Jews were by no means an inventive people. We hear nothing of their progress in literary pursuits; nor do they appear to have been industrious in borrowing from their neighbours. The laws and statutes communicated by Moses were the principal objects of their studies. These they were commanded to contemplate day and night; and in these they were to place their chief delight. The consequence of this command was, that little or no regard could be paid to taste, or any other subject of philosophical investigation. Every unimproved language abounds in figurative expressions borrowed from sensible objects. This is in a peculiar manner the characteristic of the language in question; of which it would be superfluous to produce instances, as the fact must be obvious even to the attentive reader of the English Bible.

In the course of this argument, we think it ought to be observed, and we deem it an observation of the greatest importance, that if we compare the other languages which have claimed the prize of originality from the Hebrew with that dialect, we shall quickly be convinced that the latter has a just title to the preference. The writers who have treated this subject, generally bring into competition the Hebrew, Chaldean, Syrian, and Arabian; and some one or other of these has commonly been thought the original language of mankind. The arguments for the Syrian and Arabian are altogether futile. The numerous improvements superinduced upon these languages, evidently prove that they could not have been the original language. In all cognate dialects, etymologists hold it as a maxim, that the least improved is likely to be the most ancient.

How it was cha ed into what is called th Chaldaic.

We have observed above, that the language of Abraham and that of the Chesedim or Chaldeans were originally the same; and we are persuaded, that if an able critic should take the pains to examine strictly these two languages, and to take from each what may reasonably be supposed to have been improvements or additions since the age of Abraham, he would find intrinsic evidence sufficient to convince him of the truth of this position. There appear still in the Chaldean tongue great numbers of words the same with the Hebrew,[1] perhaps as many as mankind had occasion for in the most early ages; and much greater numbers would probably be found if both languages had come down to us entire. The construction of the two languages is indeed somewhat different; but this difference arises chiefly from the superior improvement of the Chaldean. Whilst the Hebrew language was in a manner stationary, the Chaldean underwent progressive improvements; was mellowed by antitheses, rendered sonorous by the disposition of vocal sounds, and acquired a copiousness by compounds, and a majesty by affixes and prefixes. In process of time, however, the difference became so great, that the Israelites did not understand the Chaldean language at the era of the Babylonish captivity. This much the prophet intimates,[2] when he promises the pious Jews protection "from a fierce people; a people of a deeper speech than they could perceive; of a stammering tongue, that they could not understand."

The priority of the Chaldean tongue is indeed contended for by very learned writers. Camden calls it the mother of all languages;[3] and most of the Fathers were of the same opinion. Amira[4] has made a collection of arguments, not inconsiderable in favour of it; and Myriceus[5] after him, did the same. Erpenius,[6] in his Oration on the Hebrew tongue, thought the argument for it and the Chaldean so equal, that he did not choose to take upon him to determine the question.

Reasons for maintaining t priority the Hebrew.

Many circumstances, however, concur to make us assign the priority to the Hebrew, or rather to make us believe that it has suffered fewest of those changes to which every living tongue is more or less liable. If we strip this language of every thing obviously adventitious, we shall find it extremely simple and primitive. 1. Every thing masoretical, supposing the vowels and points essential,[7] was certainly unknown in its original character. 2. All the prefixed and affixed letters were added time after time, to give more compass and precision to the language. 3. The various voices, moods, tenses, numbers, and persons of verbs, were posterior improvements; for in that tongue, nothing at first appeared but the indeclinable radix. 4. In the same manner, the few adjectives which occur in the language, and the numbers and regimen of nouns, were not from the beginning. 5. Most of the Hebrew nouns are derived from verbs, indeed many of them are written with the very same letters. This rule, however, is not general; for verbs are often derived from nouns, and even some from prepositions. 6. All the verbs of that language, at least all that originally belonged to it, uniformly consist of three letters, and seem to have been at first pronounced as monosyllables. If we anatomize the Hebrew language in this manner, we shall reduce it to very great simplicity; we shall confine it to a few names of things, persons, and actions; we shall make all its words monosyllables, and give it the true characters of an original language. If at the same time we reflect on the small number of radical words in that dialect,[1] we shall be more and more convinced of its originality.

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[1] Most of the Chaldean names mentioned in Scripture are pure Hebrew words compounded; such as *Nebuchadnezzar, Nebuzuradan, Rabshakeh, Rabmag, Belshazzar, Rabsaris, Nahar, Malahtha, Phrat* or *Pharad, Barosus, Carchemish, Ur, Cutha,* Heb. *Cush,* &c. All these words, and a multitude of others which we could mention, approach so near the Hebrew dialect, that their original is discernible at first sight. Most of these are compounds, which the limits prescribed us will not allow us to analyse and explain.

[2] Isaiah xxxiii. 19.

[3] *Brit.*

[4] *Præf. ad Gram. Syr.*

[5] *Præf. ad Gram. Chald.*

[6] *Oratio de Lingua Hebr.* xii.

[7] The futility of these points will be proved in the following part of this section.

It will not be expected that we should enter into a minute discussion of the grammatical peculiarities of this ancient language. For these we must refer our readers to the numerous and elaborate grammars of that tongue, which are everywhere easily to be found. We shall only make a few strictures, which naturally present themselves, before we dismiss the subject.

. lan- ges in t east o inally t same.

The generality of writers who have maintained the superior antiquity of the Hebrew language, have at the same time contended that all other languages of Asia, and most of those of Europe, have been derived from that tongue as their source and matrix. For our own part we are of opinion, that perhaps all the languages in the eastern part of the globe were coeval with it, and were originally one and the same; and that the differences which afterwards distinguished them sprung from climate, caprice, inventions, religions, commerce, conquests, and other accidental causes, which will occur to our intelligent readers. We have endeavoured to prove, in the preceding pages, that all mankind were not concerned in the building of the fatal tower, nor affected by the punishment consequent upon that attempt; and we now add, that even that punishment was only temporary, since we find, that those very Hamites or Cushim, who are allowed to have been affected by it, did certainly afterwards recover the former organization of their tongue, and differed not more from the original standard than the descendants of Japhet and Shem.

The Jewish rabbin have pretended to ascertain the number of languages generated by the vengeance of Heaven at the building of Babel. They tell us that mankind was divided into seventy nations and seventy languages, and that each of these nations had its tutelar or guardian angel. This fabulous legend is founded on the number of the progeny of Jacob at the time when that patriarch and his family went down into Egypt. Others attribute its origin to the number of the sons and grandsons of Noah, who are enumerated in Genesis.

The Fathers[2] of the church make the languages at the confusion amount to seventy-two; which number they complete by adding Cainan and Elishah, according to the Septuagint, who are not mentioned in the Hebrew text. This opinion, they conceive, is supported by the words of Moses, where he says,[3] that "when the Most High divided to the nations their inheritance, when he separated the sons of Adam, he set the bounds of the people according to the number of the tribes of Israel." That is, say they, he divided them into seventy-two nations, which was the number of the children of Israel when they came into Egypt. The Targum of Ben-Uzziel plainly favours this interpretation; but the Jerusalem Targum intimates that the number of nations was only twelve, according to the number of the tribes of Israel. This passage, however, seems to refer to the tribes of the Chanaanim, and imports, that the Almighty assigned to the different septs of that family such a tract of land as he knew would make a sufficient inheritance for the children of Israel.[4] Others have increased the different languages of the dispersion to a hundred and twenty; but the general opinion has fixed them at seventy or seventy-two. Our readers need scarcely be put in mind that these opinions are futile and absurd, being founded neither in Scripture, profane history, nor common sense. At the same time, it must not be omitted, that according to Horus Apollo,[5] the Egyptians held, that the world was divided into seventy-two habitable regions; and that, in consequence of this tradition, they made the cynocephalus the emblem of the world, because that in the space of seventy-two days that animal pines away and dies.

Origin of the name *Hebrew.*

It has been made a question, whether the Hebrew language was denominated from Heber the progenitor of Abraham, or from a word which in that tongue imports *over, beyond.* Most of the Christian fathers, prior to St. Origen, believed that both the Gentile name *Hebrew,* and the name of the language, were derived from the name of the patriarch; but that learned man imagined, that Abraham was called the *Hebrew,* not because he was a descendant of Heber, but because he was a *transfluvianus,* or from beyond the river Euphrates. The learned Bochart[6] has strained hard to prove the former position; but to us his arguments do not appear decisive. We are rather inclined to believe, that Abraham was called *Chibri,* or Hebrew, from the situation of the country whence he emigrated when he came to the country of Chanaan; and that in process of time that word became a Gentile appellation, and was afterwards applied to his posterity often by way of reproach,[7] much in the same manner as we say a Northlander, a Norman, a Tramontane, and the like.

Here we may be indulged an observation, namely, that Abraham, a Hebrew, lived amongst the Chaldeans, travelled amongst the Chanaanites, sojourned amongst the Philistines, lived some time in Egypt, and in all appearance conversed with all those nations without any apparent difficulty. This circumstance plainly proves, that all these nations at that time spoke nearly the same language. The nations had not yet begun to improve their respective dialects, nor to deviate in any great measure from the monosyllablic idiom of the Hebrews. With respect to the language of Chanaan, afterwards the Phœnician, its similarity to the Hebrew is obvious from the names of gods, men, cities, mountains, rivers, and the like, which are the very same in both tongues, as might be shown in numberless cases, were this a proper place for etymological researches.

Before we dismiss this part of our subject, we would wish to gratify our unlearned readers with a brief account of the the Hebrew letters, and of the Masoretical points which have in a manner been ingrafted on these letters. In the course of this deduction, we shall endeavour to follow such authors as are allowed to have handled that matter with the greatest acuteness, learning, and perspicuity. If upon any occasion, we should be tempted to hazard a conjecture of our own, it is cheerfully submitted to the candour of the public.

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[1] The radical words in the Hebrew language, as it now stands, are about five hundred.

[2] Clemens Alexandr. *Strom.* Eusebius, *Chron.* lib. i. Epiphan. *Hœres. August.* &c.

[3] Deut. xxxii. 8.

[4] Pacanini Episcop. Bercun. *apud Hieron. in Catalogo Epist.* 22.

[5] 14 page, 25 *Hoesch.*

[6] *Phaleg.* lib. i. c. 15.

[7] The Egyptians might not eat bread with the Hebrews, for that is an abomination to the Egyptians. The Philistines (Samuel i. *passim*) always call the Israelites *Hebrews* by way of reproach.

Origin of alphabetic writing.

Much has been written, and numberless hypotheses proposed, with a view to investigate the origin of alphabetical writing. To give even an abridged account of all these, would fill many volumes. The most plausible, in our opinion, is that which supposes that the primary characters employed by men were the figures of material objects, analogous to those of the Mexicans, so often mentioned by the authors who have written the history of that people at the era of the Spanish invasion of their country. As this plan was too much circumscribed to be generally useful, hieroglyphical figures were in process of time invented as subsidiaries to this contracted orthography. In this scheme, we imagine, the process was somewhat more extensive. A lion might be sketched, to import fierceness or valour; an ox, to denote strength; a stag, to signify swiftness; a hare, to intimate timorousness, &c.

The next step in this process would naturally extend to the inventing and appropriating of a few arbitrary characters, for representing abstract ideas, and other relations, which could not be well ascertained by the methods above mentioned. These arbitrary signs might readily acquire a currency by compact, as money and medals do over a great part of the world. Upon this plan we imagine the ancient Chinese formed their language.

But neither the picture nor the hieroglyphic, nor the method of denoting ideas by arbitrary characters appropriated by compact, could ever have arrived at such perfection as to answer all the purposes of ideal communication. The grand desideratum then would be to fabricate characters to represent simple sounds, and to reduce these characters to so small a number as to be easily learned and preserved in the memory. In this attempt the Chinese have notoriously failed; their letters, or rather their characters, are so numerous, that few, if any, of their most learned and industrious authors, have been able to learn and retain the whole catalogue. Indeed those people are not able to conceive how any combinations of twenty or thirty characters should be competent to answer all the purposes of written language.

Many different nations have claimed the honour of this invention. The Greeks ascribed it to the Phœnicians, and used the word φοινεκιζειν,[1] *to act the Phœnician*, in the same sense with ἀναγινωσκειν, *to read;* and consequently the poet[2] ascribes the invention to the same ingenious people. The Greeks borrowed their letters from the Phœnicians, and of course looked up to them as the inventors.

Others have attributed the invention to the Egyptians. That people ascribed every useful and ingenious invention to their Thoth, or Mercury Trismegistus. Plato seems to have believed this tradition,[3] and pretends to record a dispute between the king of Egypt who then reigned and this personage, with respect to the influence which the art of alphabetic writing might possibly have upon the improvements of mankind in science and the liberal arts. Diodorus the Sicilian[4] gives a similar history of the same invention, but carries it back to the reign of Osiris.

Pliny informs us,[5] that Gellius attributed letters to the same Egyptian Mercury, and others to the Syrians; but that for "his part, he thought that the Assyrian letters were eternal." That learned Roman, then, imagined, that the Assyrian letters had existed at a period prior to all the records of history, which in fact was the case. By the Assyrian letters, he must mean the Chaldaic, and by the Syrian probably the Hebrew. The earliest Greek historians generally confound the Jews with the Syrians. Herodotus, enumerating the people who had learned circumcision from the Egyptians, mentions the Syrians of Palestine;[6] and elsewhere he tells us, that Necho beat the Syrians, and took Cadytis, a large and populous city belonging to that people.[7] Hence it is evident that the Syrian alphabet, or the Syrian letters, were the same with the Hebrew. That the Assyrian or Chaldaic and Hebrew languages were the same, has, we conceive, been fully proved already; that their letters were the same in the original structure, can scarcely be controverted.

Antedi vian.

These letters were, we think, antediluvian; whether, to use the expression of Plato, they were dictated by some god, or fabricated by some man divinely inspired. As this opinion may admit some dispute, we shall take the liberty to subjoin our reasons for entertaining it.

1. It appears that the era of this invention is involved in impenetrable obscurity. Had an invention of such capital importance to mankind been made in the postdiluvian ages, we imagine the author would have been commemorated in the historical annals of the country where he lived.[8]

2. The art of writing in alphabetical characters, according to the sacred records, was practised at so early a period, that there was not a long enough interval between that and the deluge to give birth to this noble invention. If we consider the state of the world during some ages after that disastrous event, we shall quickly be convinced that little respite could be found from the labour and industry indispensably requisite to provide the necessaries, and only a few of the conveniencies of life. Such a state of things was certainly most unfavourable to the invention of those arts and improvements which contribute nothing towards procuring the accommodations of life. The consequence is obvious.

Moses has recorded the history of the creation, and a few of the capital transactions of the antediluvian world, the birth, the age, the death, of the lineal descendants of Seth. He has preserved the dimensions of the ark, the duration of the universal deluge, its effects upon man and all terrestrial animals, the population of the world by the posterity of Noah, the age, &c. of the patriarchs of the line of Shem, from which his own ancestors had sprung. To this he has subjoined the petty occurrences which diversified the lives of Abraham, and Isaac, and Jacob, and their descendants. Whence did the historian derive his information? We believe few of our readers will be so enthusiastic as to imagine that the author received it from divine inspiration. Tradition is a fallible guide; and in many cases the accounts are so minutely precise, as to defy the power of that species of conveyance. The inspired author must certainly have extracted his abridgment from written memoirs, or histories of the transactions of his ancestors regularly transmitted from the most early periods. These annals he probably abridged, as Ezra did afterwards the history of the kings of Israel. Supposing this to be the case, as it most certainly was, the art of writing in alphabetical letters must have been known and practised many ages before Moses. It has indeed been pretended, that the Jewish decalogue, inscribed upon two tables of stone, was the very first specimen of alphabetical writing. But the arguments produced in proof of this notion are lame and inconclusive.[9] Had that been the case, some notice must have been taken of so palpable a circumstance. Moses wrote out his history, his laws, and his memoirs; and it appears plainly from the text, that all the learned amongst his countrymen could read them. Writing was then no novel invention in the age of the Jewish legislator, but current and generally known at that era.

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[1] Hesych. [2] Lucan. [3] See *Phædrus*, p. 1240; and also *Phil.* p. 374. [4] *Bibl.* lib. i. p. 10. Steph.

[5] *Nat. Hist.* lib. vii. c. 46. [6] Lib. ii. c. 104. [7] Ibid. c. 159.

[8] It is true, the Egyptians attribute the invention to their Thoth, and the Phœnicians to their Hercules, or Melicerta or Baal; but these were only imaginary personages.

[9] The most ingenious and plausible of those arguments which have fallen under our observation, is given by Mr. Johnson, vicar of Cranbrook, a writer of great learning and piety, who flourished in the beginning of the eighteenth century, and whose works deserve to be more generally known than we have reason to think they are. After endeavouring to prove that alphabetical writing was not practised before the era of Moses, and expatiating upon the difficulty of the invention, this excellent scholar attempts to show, that the original Hebrew

The patriarch Job lived at an earlier period. In the book of the same name we find many allusions to the art of writing, and some passages which plainly prove its existence. This shews that alphabetical characters were not confined to the chosen seed, since Job was in all probability a descendant of Huz, the eldest son of Nahor,[1] the brother of Abraham. From this circumstance, we think we may fairly conclude, that the art of writing was known and practised in the family of Terah the father of Abraham.

radition specting ting.

3. There was certainly a tradition amongst the Jews in the age of Josephus, that writing was an antediluvian invention.[2] That historian pretends, that the descendants of Seth erected two pillars, the one of stone and the other of brick, and inscribed upon them their astronomical observations and other improvements. This legend shows that there did exist such an opinion in regard to the antiquity of the art of writing.

4. There must have been a tradition to the same purpose amongst the Chaldeans, since the writers who have copied from Berosus, the celebrated Chaldean historian,[3] speak of alphabetical writing as an art well known amongst the antediluvians. According to them, Oannes the Chaldean legislator gave his disciples an insight into letters and science. This person also *wrote* concerning the generation of mankind, of their different pursuits, of civil polity, and other matters. Immediately before the deluge, say they, the god Kronos appeared to Sisuthrus or Xisuthrus, and commanded him to commit to writing the beginning, improvement, and conclusion of all things down to the present time, and to bury these accounts securely in the temple of the Sun at Seppara. All these traditions may be deemed fabulous in the main; but still they evince that such an opinion was current, and that although the use of letters was not indeed eternal,[4] it was, however, prior to all the records of history; and of course, we think, an antediluvian discovery.

The original alphabet preserved in the family of Noah.

This original alphabet, whatever it was, and however constructed, was, we think, preserved in the family of Noah, and from it conveyed down to succeeding generations. If we can then discover the original Hebrew alphabet, we shall be able to investigate the primary species of letters expressive of those articulate sounds by which man is in a great measure distinguished from the brute creation. Whatever might be the nature of that alphabet, we may be convinced that the ancient Jews deemed it sacred, and therefore preserved it pure and unmixed until the Babylonian captivity. If, then, any monuments are still extant inscribed with letters prior to that event, we may rest assured that these are the remains of the original alphabet.

The same with the Samaritan.

There have, from time to time, been dug up at Jerusalem, and other parts of Judea, coins and medals, and medallions, inscribed with letters of a form very different from those square letters in which the Hebrew Scriptures are now written. When the Samaritan Pentateuch was discovered,[5] it evidently appeared that the inscriptions on those medals and coins were drawn in genuine Samaritan characters. The learned Abbé Barthélèmi, in his disser-

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alphabet was actually communicated to the Jewish legislator at the same time with the two tables of the law. "I know not," says he, "any just cause why the law should be *written by God*, or by *an angel* at his command, except it were for want of a man that could well perform this part. This could give no addition of authority to the law, especially after it had been published in that astonishing and miraculous manner at Mount Sinai. The true writing of the original was indeed perfectly adjusted, and precisely ascertained to all future ages, by God's giving a copy of it under his own hand; but this, I conceive, had been done altogether as effectually by God's dictating every word to Moses, had he been capable of performing the office of an amanuensis." The learned writer goes on to suppose, that it was for the purpose of teaching Moses the alphabet, that God detained him forty days in the Mount; and thence he concludes, that the Decalogue was the first writing in alphabetical characters, and that these characters were a divine, and not a human invention.

It is always rash, if not something worse, to conceive reasons not assigned by God himself, for any particular transaction of his with those men whom he from time to time inspired with heavenly wisdom. That it was *not* for the purpose of teaching Moses the alphabet that God detained him forty days in the Mount, when he gave him the two tables of the law, seems evident from his detaining him just as many days when he gave him the second tables after the first were broken. If the legislator of the Jews had not been sufficiently instructed in the art of reading during his first stay in the Mount, he would have been detained longer; and it is not conceivable, that though in a fit of pious passion he was so far thrown off his guard as to break the two tables, his mind was so totally unhinged by the idolatry of his countrymen, as to forget completely an art which, by the supposition, the Supreme Being had spent *forty days* in teaching him. "But if Moses could, at his first ascent into the Mount, perform the office of an amanuensis, why are the original tables said to have been written by the finger of God, and not by him who wrote the second?" We pretend not to say why they were written by God rather than man; but we think there is sufficient evidence, that by whomsoever they were written, the characters employed were of human invention. The Hebrew alphabet, without the Masoretic points, is confessedly defective; and every man who is in any degree acquainted with the language, and is not under the influence of inveterate prejudice, will readily admit that those points are no improvement. But we cannot, without impiety, suppose an art invented by infinite wisdom, to fall short of the utmost perfection of which it is capable. An alphabet communicated to man by God, would undoubtedly have been free both from defects and from redundancies; it would have had a distinct character for every simple sound, and been at least as perfect as the Greek or the Roman.

But we need not fill our pages with reasonings of this kind against the hypothesis maintained by Mr. Johnson. We know that "Moses wrote all the words of the Lord," that is, the substance of all that had been delivered, in Exod. xx, xxi, xxii, xxiii, before he was called up into the Mount to receive the tables of stone; nay, that he had long before been commanded by God himself, to "write in a book" an account of the victory obtained over Amalek, (Exod. xvii. 14.) All this, indeed, the learned writer was aware of; and to reconcile it with his hypothesis, he frames another, more improbable than even that which it is meant to support. "It is not unreasonable," says he, "to believe that God had written these tables of stone, and put them in Mount Horeb, from the time that by his angel he had there first appeared to Moses; and that, therefore, all the time after, whilst he kept Jethro's sheep thereabouts, he had free access to those tables, and perused them at discretion." But if belief should rest upon evidence, we beg leave to reply, that to believe all this would be in the highest degree unreasonable; for there is not a single hint in the Scripture of the tables having been written at so early a period, or upon such an occasion, as God's first appearance to Moses in the burning bush. We know how reluctant Moses was to go upon the embassy to which he was then appointed; and it is strange, we think passing strange, that when he records so faithfully his own backwardness, and the means made use of by God to reconcile him to the arduous undertaking, he should make no mention of these important tables, if at that period he had known any thing of their existence. Besides all this, is it not wonderful, that, if Moses had been practising the art of writing, as our author supposes, from the time of the burning bush to the giving of the law, he should then have stood in need of forty days teaching from God, to enable him to read with ease the first tables, and of other forty, to enable him to write the second? This gives such a mean view of the natural capacity of the Hebrew legislator, as renders the hypothesis which implies it wholly incredible. (See a *Collection of Discourses*, in two vols. by the Rev. John Johnson, vicar of Cranbrook in Kent.)

[1] Gen. xxii. 20, &c.

[2] *Antiq. Jud.* lib. i. c. 3.

[3] Apollodorus, Alexander Polyhistor, Abydenus. (See *Syncellus*, cap. 39, *et seq. Euseb. Chron.* lib. i. p. 3.)

[4] Plin. Nat. Hist. lib. vii. p. 413. *Ex quo apparet æternus literarum usus.*

[5] The celebrated Archbishop Usher was the first who brought the Samaritan Pentateuch into Europe. In a letter to Ludovicus Capellus "he acknowledges, that the frequent mention he had seen made of it by some authors, would not suffer him to be at rest till he had procured five or six copies of it from Palestine and Syria."

tation[1] "on the two medals of Antigonus, king of Judea, one of the later Asmonean princes, proves that all the inscriptions on the coins and medals of Jonathan and Simon Maccabeus, and also on his, were invariably in the Samaritan character down to the fortieth year before the Christian era."

This afterwards gave place to the Chaldaic.

It were very easy to prove, from the Misna and Jerusalem Talmud, that the Scriptures publicly read in the synagogues to the end of the second century were written in the Samaritan character, we mean in the same character with the Pentateuch in question. As the ancient Hebrew, however, ceased to be the vulgar language of the Jews after the return from the Babylonian captivity, the copies of the Bible, especially in private hands, were accompanied with a Chaldaic paraphrase; and at length the original Hebrew character fell into disuse, and the Chaldaic was universally adopted.

It now appears that the letters inscribed upon the ancient coins and medals of the Jews, were written in the Samaritan form, and that the Scriptures were written in the very same characters. We shall therefore leave it to our readers to judge whether, considering the implacable hatred which subsisted between these two nations, it be likely that the one copied from the other; or at least that the Jews preferred to the beautiful letters used by their ancestors, the rude and inelegant characters of their most detested rivals. If, then, the inscriptions on the coins and medals were actually in the characters of the Samaritan Pentateuch (and it is absurd to suppose that the Jews borrowed them from the Samaritans,) the consequence plainly is, that the letters of the inscriptions were those of the original Hebrew alphabet, coeval with that language, which we venture to maintain was the first upon earth.

It may, perhaps, be thought rather superfluous to mention, that the Samaritan colonists, whom the kings of Assyria planted in the cities of Samaria,[2] were natives of countries where the Chaldaic letters were current, and who were probably ignorant of the Hebrew language and characters. When those colonists embraced the Jewish religion, they procured a copy of the Hebrew Pentateuch written in its native character, which, from superstition, they preserved inviolate as they received it; and from it were successively copied the others which were current in Syria and Palestine when Archbishop Usher procured his.

From the reasons above explained, then, we hope it will be obvious, that if the Hebrew alphabet, as it appears in the Samaritan Pentateuch, was not the primitive one, it was at least that in which the Holy Scriptures were first committed to writing.

The Chaldaic introduced by Ezra.

Scaliger has inferred, from a passage in Eusebius,[3] and another in St. Jerome,[4] that Ezra, when he reformed the Jewish church, transcribed the Scriptures from the ancient characters of the Hebrews into the square letters of the Chaldeans. This, he thinks, was done for the use of those Jews who, being born during the captivity, knew no other alphabet than that of the people amongst whom they had been educated. This account of the matter, though probable in itself, and supported by passages from both Talmuds, has been attacked by Buxtorf with great learning and no less acrimony. Scaliger, however, has been followed by a crowd of learned men,[5] whose opinion is now pretty generally espoused by the sacred critics.

Having said so much concerning the Hebrew alphabet in the preceding pages, we find ourselves laid under a kind of necessity of hazarding a few strictures on the vowels and Masoretic points; the *first* essential to, and the *last* an appendage of, that ancient language. The number of the one, and the nature, antiquity, and necessity of the other, in order to read the language with propriety and with discrimination, have been the subject of much and often illiberal controversy amongst philological writers. To enter into a minute detail of the arguments on either side, would require a complete volume. We shall, therefore, briefly exhibit the state of the controversy, and then venture a few observations, which, in our opinion, ought to determine the question.

The H brew v els.

The controversy then is, whether the Hebrews used any vowels, or whether the points, which are now called by that name, were substituted instead of them? or if they were, whether they be as old as the time of Moses, or were invented by Ezra, or by the Masorites?[6] This controversy has exercised the ingenuity of the most learned critics of the two last centuries, and is still far enough from being determined in the present. The Jews maintain, that these vowel points[7] were delivered to Moses along with the tables of the law, and consequently hold them as sacred as they do the letters themselves. Many Christian authors who have handled this subject, although they do not affirm their divine original, nor the extravagant antiquity of these points, pretend, however, that they are the only proper vowels in the language, and regulate and ascertain its true pronunciation. Though they differ from the Jews with respect to the origin of these points, they yet allow to them a pretty high antiquity, generally ascribing them to Ezra and the members of the great synagogue.

The M retic p a moder inventio

At length, however, about the middle of the sixteenth century, Elias Levita, a learned German Jew, who then flourished at Rome, discovered the delusion, and made it appear that these appendages had never been in use till after the writing of the Talmuds, about five hundred years after Christ. This innovation raised Elias a multitude of adversaries, both of his own countrymen and Christians. Amongst the latter appeared the two Buxtorfs, the father and the son, who produced some cabbalistical books of great antiquity,[8] at least in the opinion of the Jews, in which mention was expressly made of the points. The Buxtorfs were answered by Capellus and other critics,[9] till Father Morinus,[10] having examined all that had been urged on both sides, produced his learned dissertation on that subject; against which there has been nothing replied of any consequence, whilst his work has been universally admired, and his opinion confirmed by those that have beaten the same field after him.

According to this learned father, it plainly appears that neither Origen, nor St. Jerome, nor even the compilers of the Talmuds, knew any thing of what has been called the vowel points; and yet these books, according to the same author, were not finished till the seventh century. Even the Jewish rabbin who wrote during the eighth and ninth centuries, were not, according to him, in the least acquainted with these points. He adds, that the first vestiges he could trace of them were in the writings of Rabbi Ben Aber chief of the western, and of Rabbi Ben Naphtali, chief of the eastern school, that is, about the middle of the tenth century; so that they can hardly be said to be older than the beginning of that period.

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[1] *Mémoires de l'Académie des Inscript.*

[2] 2 Kings xvii. 24. "And the king of Assyria brought men from Babylon, and from Cuthah, and from Avah, and from Hamath, and from Sepharvaim, and placed them in the cities of Samaria." Babylon and Cuthah, and Avah, were neighbouring cities, and undoubtedly both spoke and wrote in the Chaldaic style. The natives of Hamath spoke the Syriac, which at that time differed very little from the Chaldaic.

[3] *Chron. in anno*, 740.

[4] *Præf.* i. *Reg.*

[5] Casaubon, Grotius, Vossius, Bochart, Morin, Brerewood, Walton, Prideaux, Huet, and Lewis Capel, always a sworn enemy to Buxtorf. All these have maintained the same ground with Scaliger; how truly, appears above.

[6] The term *masorah* or *massoreth* signifies "tradition," and imports the unwritten canon by which the reading and writing of the sacred books was fixed.

[7] These points are fourteen in number, and their figures, names, and effects, may be seen in most Hebrew Grammars.

[8] These books are the *Bahir*, *Zahar*, and the *Kizri*. As for the Kizri, the Jews make it about nineteen hundred years old; and the other about a century later. But the fidelity of the Jews in such matters cannot be relied upon.

[9] Walton, Dupin, and Vossius.

[10] *Dissertation sur la Bible.*

Some learned men[1] have ascribed the invention of the vowel points in question to the rabbin of the school of Tiberias; which, according to them, flourished about the middle of the second century. This opinion is by no means probable, because it appears plain from history, that before that period all the Jewish seminaries in that province were destroyed, and their heads forced into exile. Some of these had retired into Babylonia, and settled at Sora, Naherds, and Pombeditha, where they established famous universities. After this era, there remained no more any rabbinical schools in Judea, headed by professors capable of undertaking this difficult operation, nor indeed of sufficient authority to recommend it to general practice, had they been ever so thoroughly qualified for executing it.

The *matres ectionis.*

Capellus and Father Morin, who contend for the late introduction of the vowel-points, acknowledge that there can certainly be no language without vocal sounds, which are indeed the soul and essence of speech; but they affirm that the Hebrew alphabet actually contains vowel characters, as well as the Greek and the Latin, and the alphabets of modern Europe. These are *aleph, he, vau, jod,* which they call the *matres lectionis,* or, if you please, the parents of reading, and to which some, we think very properly, add *ain* or *oin, ajin.* These, they conclude, perform exactly the same office in Hebrew that their descendants do in Greek. It is indeed agreed, upon all hands, that the Greek alphabet is derived from the Phœnician, which is known to be the same with the Samaritan or Hebrew. This position we shall prove more fully when we come to trace the origin of the Greek tongue. Hitherto the analogy is not only plausible, but the resemblance is precise. The Hebrews and Samaritans employed these vowels exactly in the same manner with the Greeks; and so all was easy and natural.

bjections swered.

But the assertors of the Masoretic system maintain that the letters mentioned above are not vowels but consonants or aspirations, or any thing you please except vocal letters. This they endeavour to prove from their use amongst the Arabians, Persians, and other oriental nations. But to us it appears abundantly strange to suppose that the Greeks pronounced *beta, gamma, delta,* &c. exactly as the Hebrews and the Phœnicians did, and yet at the same time did not adopt their mode of pronunciation with respect to the five letters under consideration. To this argument we think every objection must undoubtedly yield. The Greeks borrowed their letters from the Phœnicians; and these letters were the Hebrew or Samaritan. The Greeks wrote and pronounced all the other letters of their alphabet, except the five in question, in the same manner with their originals of the east;[2] and if they did so, it obviously follows that the Greek and oriental office of these letters was the same.

Another objection made to reading the Hebrew without the aid of the Masoretic vowel points, arises from the consideration, that without these there will be a great number of radical Hebrew words, both nouns and verbs, without any vowel intervening amongst the consonants, which is certainly absurd. But notwithstanding this supposed absurdity, it is a well known fact, that all the copies of the Hebrew Scriptures, used in the Jewish synagogues throughout the world, are written or printed without points. These copies are deemed sacred, and kept in a coffer with the greatest care, in allusion to the ark of the testimony in the tabernacle and temple. The prefect, however, reads the portions of the law and hagiography without any difficulty. The same is done by the remains of the Samaritans at this day. Every oriental scholar knows that the people of these countries look upon consonants as the stamina of words. Accordingly, in writing letters, in dispatches upon business, and all affairs of small moment, the vowels are generally omitted. It is obvious, that in every original language the sound of the vowels is variable and of little importance. Such was the case with the Hebrew tongue. Nor do we think that the natives of the country would find it a matter of much difficulty to learn to read without the help of the vowels. They knew the words before hand, and so might readily enough learn by practice what vowels were to be inserted.

Proof that the Masoretic points are modern.

When the Hebrew became a dead language, as it certainly was in a great measure to the vulgar, after the return from the Babylonian captivity, such subsidiaries might we think, have been useful, and of course might possibly have been adopted for the use of the vulgar; but the scribe, the lawyer, and the learned rabbi, probably disdained such beggarly elements. We shall in this place hazard a conjecture, which, to us at least, is altogether new. We imagine that the Phœnicians, who were an inventive and ingenious people, had, prior to the age of Cadmus, who first brought their letters into Greece, adopted the more commodious method of inserting the vowels in their proper places; whereas the Jews, zealously attached to the customs of their ancestors, continued to write and read without them. In this manner the Gephuræi,[3] who were the followers of Cadmus, communicated them to the Iones, their neighbours. We are convinced that the materials of the Greek tongue are to be gleaned up in the east; and upon that ground we have often endeavoured to trace the origin of Greek words in the Hebrew, Phœnician, Chaldean, and Arabian languages. Reading without the vowel points we have seldom failed in our search; but when we followed the method of reading by the Masoretic points, we seldom succeeded; and this, we believe, every man of tolerable erudition who will make the trial, will find by experience to be true. This argument appears to us superior to every objection. Upon this basis, the learned Bochart has erected his etymological fabric, which will be admired by the learned and ingenious as long as philology shall be cultivated by men.

It has been urged by the zealots for the Masoretic system, that the Arabians and Persians employ the vowel points. That they do so at present is readily granted; but whether they did so from the beginning is the question to be resolved. That Arabia was overspread with Jewish exiles at a very early period, is abundantly certain. It was natural for them to retire to a land where they would not hear of war, nor the sound of the trumpet. Accordingly we find that, prior to the age of the Arabian impostor, Arabia swarmed with Jewish settlements. From these Jews, it is highly probable that their neighbours learned the use of the points in question; which in the course of their conquests the Saracens communicated to the Persians.

It has been alleged with great show of reason, that without the vowel points, it is often impossible to develope the genu-

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[1] See Buxtorf the father, *in Tiber.* cap. 5, 6, 7. Buxtorf the son, *de Antiq. Punct.* p. ii. 11.

[2] This is so true, that, according to Hesychius and Suidas, φοινικιζειν, to act the Phœnician, signified "to read."

[3] Herod. lib. i. cap. 56.

Hebrew Language.

ine signification of many words which occur frequently in the language, and that many words of different and sometimes opposite significations are written with exactly the same consonants. Without the points, then, how are we to know the distinction? In answer to this objection, we beg leave to observe, that, during the first period of a language, it is impossible that there should not occur a number of similar sounds of different significations. This is surely to be attributed to the poverty of the language. When a few terms have been once fabricated, men will rather annex new significations to old terms, than be at the expense of time or thought to invent new ones. This must have been the case with the Hebrew in particular; and indeed no language on earth is without instances of this inconveniency, which, however, in a living tongue, is easily overcome by a difference of accent, tone, gesture, pronunciation; all which, we think, might obviate the difficulty.

From the preceding arguments, we think ourselves authorised to infer that the Masora is a novel system, utterly unknown to the most ancient Jews, and never admitted into those copies of the Scriptures which were deemed most sacred and most authentic by that people.

With respect to the original introduction of the points, we agree with the learned and judicious Dr. Prideaux,[1] who imagines that they were gradually introduced after the Hebrew became a dead language, with a view to facilitate the learning to read that language, more especially amongst the vulgar. By whom they were introduced, cannot, we think, be easily determined; nor is it probable that they were all introduced at once, or by one and the same person. They have been ascribed to Ezra by many, for no other reason that we can discover, but to enhance their authenticity, and because the sentiment is analogous to the other articles of reformation established by that holy priest. If the curious reader should not be satisfied with the preceding detail, we must remit him to Copellus and Morinus, on the one side, and the two Buxtorfs, Schultens, and Dr. James Robertson, formerly professor of oriental languages in the university of Edinburgh, on the other. This learned orientalist, in his dissertation prefixed to his *Clavis Pentateuchi*, has collected and arranged, with the true spirit of criticism, every thing that has been advanced in favour of the Masoretical system. *Si Pergama dextra defendi possent, etiam hac defensa fuissent.*

Origen's Hexapla.

St. Origen, who flourished about the beginning of the third century, was a profound Hebrew scholar. He published a most laborious and learned work, which is generally called the *Hexapla*, because it consisted of six columns, the first of which contained the Hebrew text; the second, the same text, but written in Greek characters; the third column exhibited the version of Aquila; the fourth that of Symmachus; the fifth, the Septuagint; and the sixth, the version of Theodotan. In some fragments of that great work which are still extant, we have a specimen of the manner in which the Hebrew was pronounced in the third century, by which it appears that it was very different from that which results from observing the Masoretical points. The following is an instance copied from the beginning of Genesis.

According to Origen.

בראשית ברא אלהים את השמים ואת הארץ : והארץ
היתה תהו ובהו והשך על־פני תהום ורוה אלהים מרחפת
על־פני המים : ויאמר אלהים יהי אור ויהי־אור : וירא
אלהים את־האור כי־טוב ויבדל אלהום בין האור ובין
החשך : [2]

According to the Masorites.

Hebrew Languag

בְּרֵאשִׁית בָּרָא אֱלֹהִים אֵת הַשָּׁמַיִם וְאֵת הָאָרֶץ : וְהָאָרֶץ
הָיְתָה תֹהוּ וָבֹהוּ וְחֹשֶׁךְ עַל־פְּנֵי תְהוֹם וְרוּחַ אֱלֹהִים מְרַחֶפֶת
עַל־פְּנֵי הַמָּיִם : וַיֹּאמֶר אֱלֹהִים יְהִי אוֹר וַיְהִי־אוֹר : וַיַּרְא
אֱלֹהִים אֶת־הָאוֹר כִּי־טוֹב וַיַּבְדֵּל אֱלֹהִים בֵּין הָאוֹר וּבֵין
הַחֹשֶׁךְ : [3]

Practice o the ancie Greeks.

Upon the whole, we presume to give it as our opinion, that in the most early periods, the vowels, *aleph*, *he*, *jod* or *yod*, *vaw* or *waw*, and perhaps *oin* or *ajin*, were regularly written wherever they were sounded. This appears to us plain from the practice of the ancient Greeks. It is agreed upon all hands that the Samaritan and Phœnician alphabets were the same; and that the former was originally the same with that of the Jews. The Phœnicians certainly wrote the vowels exactly, for so did the Greeks who copied their alphabet. If the Phœnicians wrote their vowels, so then did the Jews of the age of Cadmus; but as Cadmus was contemporary with some of the earliest judges of Israel, the consequence is evident, namely, that the Jews wrote their vowels as late as the arrival of that stranger in Greece. We ought naturally to judge of the Hebrew by the Chaldaic, Syriac, and Arabic, its sister dialects. But in ancient times all these languages had their vowels regularly inserted; and why not the Hebrew in the same manner with the rest?

As these first vowels which were coeval with the other letters, often varied in their sound and application, the points, in all appearance, were first invented and employed to ascertain their different sounds in different connections. Other marks might be invented to point out the various tones of voice, like the τονοι, or accents, with which the vowels were to be enounced, as was done amongst the later Greeks. In process of time, in order to promote celerity of writing, the vowels were omitted, and the points substituted in their place.

Before we conclude our observations on the Hebrew language, we ought perhaps to make an apology for omitting to interlard our details with quotations from the two Talmuds, the Mishna, the Gemara, the Cabbalas, and a multitude of Rabbinical writers who are commonly cited upon such an occasion. We believe we could have quoted almost numberless passages from the two Buxtorfs, Father Morin, Capellus, and other Hebrew critics, with no great trouble to ourselves, and little advantage to the far greater part of our readers. But our opinion is that such a pedantic display of philological erudition would probably have excited the mirth of our learned, and roused the indignation of our unlearned, readers. Our wish is, to gratify readers of both descriptions, by contributing to the edification of one class without disgusting the other. We cannot, however, take leave of the sacred language, without giving a brief detail of those excellencies, which, in our opinion, give it a just claim to superiority over those other tongues which have sometimes contended with it for the prize of antiquity; and of these the following in our apprehension deserve particular notice.

Excellen- cies of th Hebrew language

If this language may claim any advantage over its antagonists, with respect to its being rather a mother than a daughter of any of them, it is undoubtedly in consequence of its simplicity, its purity, its energy, its fecundity of expressions and significations. In all these, notwithstanding

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[1] *Connect.* part i book i.

[2] Brêsith bara Elôeim eth asamaim oueth aares. Ouaares aietha thôau ouboou ouôsekh al phne theôm ouroué elôeim maraepheth al phne amaim. Ouiômer elôeim iei ôr ouiei ôr Ouiar elôeim eth aôr khi tôb ouiabdêl elôeim bên aôr oubên aôsekh.

[3] Bereshith bara Elohim eth ashamajim veeth aaretz. Veaaretz ajetha thoou vaboou, vekhoshek gnal pené theom verouakh elohim merakhepheth gnal pené hammáim. Vaïomer elohim jehi or, vajehi or. Vajare elohim eth aor ki tob vajabedel elohim bein aor oubein hakhoshek.

Hebrew language.

its paucity of words, it excels the vast variety of other languages which are its cognate dialects. To these we may add the significancy of the names, both of men and brutes; the nature and properties of the latter of which are more clearly and more fully exhibited by their names in this than in any other tongue hitherto known. Besides, its well authenticated antiquity, and the venerable tone of its writings, surpass any thing left upon record in any other dialect now extant in the world. These extraordinary qualities must excite our admiration under every disadvantage; and from the same circumstance we may infer its incomparable beauty in the age of the Jewish legislator, and what effects it would naturally produce, could we know it now as it was spoken and written in the days of David and Solomon.

As far, however, as we understand it in its present mutilated condition, and are able to judge of its character from the few books which have come down to our time, we plainly perceive that its genius is simple, primitive, natural, and exactly conformable to the character of those uncultivated patriarchs who used it them themselves, and transmitted it to their descendants in its native purity and simplicity. Its words are comparatively few, yet concise and expressive; being derived from a very small number of radicals, without the artificial composition of modern languages. No tongue, ancient or modern, can rival it in the happy and rich fecundity of its verbs, resulting from the variety and significancy of its conjugations; which are so admirably arranged and diversified, that by changing a letter or two of the primitive, they express the various modes of acting, suffering, motion, rest, &c., in so precise and significant a manner, that frequently in one word they convey an idea which, in any other language, would require a tedious paraphrase. These positions might easily be illustrated by numerous examples; but to the Hebrew scholar they would be superfluous, and to the illiterate neither interesting nor entertaining.

To these we may add the monosyllabic tone of the language, which, by a few prefixes and affixes without affecting the radix or root, varies the signification almost at pleasure, whilst the method of affixing the person to the verb exhibits the gender of the object introduced. In the nouns of this language there is no flexion excepting what is necessary to point out the difference of gender and number. Its cases are distinguished by articles, which are merely single letters placed at the beginning of the word. The pronouns are only single letters affixed; and the prepositions are of the same character prefixed to words. Its words follow one another in an easy and natural arrangement, without intricacy or transposition, without suspending the attention or involving the sense by intricate and artificial periods. All these striking and peculiar excellencies combined, plainly demonstrate the beauty, the stability, and the antiquity of this most interesting and remarkable language.

We would not, however, be thought to insinuate that this tongue continued altogether without changes and imperfections. We admit that many of its radical words were lost in a course of ages, and that foreign ones were substituted in their place. The long sojourning of the Israelites in Egypt, and their close connection with that people, even *quoad sacra*, must have introduced, into the vulgar dialect at least, a multitude of Egyptian vocables and phrases which have gradually been incorporated with the written language, and in process of time have become part of its essence. In Egypt, the Israelites imbibed those principles of idolatry which nothing less than the final extirpation of their polity could eradicate. If that people, then, were so obstinately attached to the Egyptian idolatry, it is not very probable that they would be averse to adopt the Egyptian language. Besides, the Scripture informs us, that there departed out of Egypt a mixed multitude; a circumstance which must have infected the Hebrew language with the dialect of Egypt. Hence, as none of the genuine Hebrew radicals exceed three letters, whatever words exceed that number in their radical state may justly be deemed of foreign extraction.

Arabic Language.

Some Hebrew critics have thought that verbs constitute the radicals of the whole language. But this opinion appears to us to be ill-founded; for although many Hebrew nouns are undoubtedly derived from verbs, we at the same time find numbers of the latter deduced from the former.

Hutchinsonianism.

Before we conclude what we have to say of the Hebrew tongue, our readers may possibly imagine that we ought to give some account of the Hutchinsonian system, which was at one time so highly in vogue. But as this allegorical scheme of interpretation is now in a great measure exploded, we shall beg leave to refer the curious Hebraist to Mr. Holloway's *Originals*, a small book in two volumes octavo, but replete with multifarious erudition, especially in the Hutchinsonian style and character. *Fides sit penes autorem.*

SECT. II. THE ARABIC LANGUAGE.

Arabic language originally Hebrew.

We shall now proceed to give some account of the Arabian language, which is evidently one of the sister dialects of the Hebrew. Both, we imagine, were originally the same; the former highly improved and enlarged; the latter, in appearance, retaining its original simplicity and rude aspect, spoken by a people of a genius by no means inventive. In this inquiry, too, as in the former, we shall spare ourselves the trouble of descending to the grammatical minutiæ of the tongue; a method which, we are persuaded, would neither gratify our learned nor edify our unlearned readers. To those who are inclined to acquire the first elements of that various, copious, and highly improved tongue, we beg to recommend Erpenii *Rudimenta Linguæ Arabicæ;* Golii *Grammatica Arabica;* the Dissertations of Hariri, translated by the elder Schultens; and Mr. Richardson's Persic and Arabic Grammar.

We have said that the Hebrew and the Arabic are sister dialects, a relation which, as far as we know, has been seldom controverted; but we think there is authentic historical evidence that they were positively one and the same, at a period when the one as well as the other appeared in its infant unadorned simplicity. The following detail will, we hope, fully authenticate the truth of our position.

"Unto Eber," says the Scripture,[1] "were born two sons. The name of one was Peleg, because in his days the earth was divided; and his brother's name was Joktan," or rather Yoktan. This last, says the sacred historian, "had thirteen sons; and their dwelling reached from Mesha (Mocha) to Sephar,"[2] a mount of the east. According to this account, the descendants of Yoktan possessed all the maritime coasts of Arabia from Mesha (Mocha) to Mount Sephar towards the east of that peninsula. Moses, describing the rivers of paradise, tells us, that one of the branches of that river[3] "encompassed the whole land of Havilah, where there was great store of gold." Havilah was the twelfth son of Yoktan, whom the Arabians call Kobtan; and consequently his territory was situated towards the eastern limit of the possessions of the posterity of the youngest son of Eber. Yoktan or Kobtan was too young to be concerned in the building of the tower at Babel; and consequently he retained the language of his family, which was undoubtedly the Hebrew. His descendants must have carried the same language into their respective settlements, where it would be regularly transmitted to succeeding generations. The original language of all the tribes of the Arabians who inhabit a vast tract of country along the southern shore was, according to this deduction, that of their father Kobtan, in other words, the Hebrew. Indeed, the most learned Arabians of modern times unanimously acknowledged this patriarch as the founder of their language as well as of their nation.

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[1] Gen. x. 25.

[2] Sephar, in the Septuagint Σοφηρα, and in some editions Σωφηρα; hence probably Σωφειρ. Orig. *in Job.* xxii. 14. Φασι δε τινες των Ερμηνεων Σωφειρ την Ἀφρικην εἶναι.

[3] Gen. ii. 11.

The other districts of Arabia were peopled by the offspring of Abraham. The Ishmaelites, the posterity of that patriarch by Hagar, penetrated into the very centre of the peninsula, where they incorporated, and in process of time became one people with the Kobtanites. Another region was possessed by the children of the same holy man by Cheturah his second wife. The Moabites, Ammonites, Edomites, Amalekites, and others, who settled in the various regions of Arabia Petræa, were all branches of Abraham's family, and used the same language with their great progenitor. The Scripture indeed speaks of people who inhabited the country last mentioned prior to the branches of Abraham's family; but these, according to the same history, were extirpated by the former. The conclusion then is, if we credit the Mosaic account, that all the inhabitants of the three divisions of Arabia did, in the earliest periods, universally use the Hebrew tongue.

We are sensible that there was a region of Arabia inhabited by the Cushim, or descendants of Cush. This district was situated on the confines of Babylonia. Our translators have confounded this country with the modern Ethiopia, and consequently ascribed the exploits performed by the Arabian Cushim to the Ethiopians. The Arabian kings of Babylon were of those Cushim; but they were conquered and expelled Babylonia by the Chasidim. The latter spoke the Chaldean dialect, as will appear when we come to speak of that of the Abyssinians. Here the reader is desired to reflect that the Hebrew and Chaldaic are cognate dialects.

The foregoing proofs, deduced from the Mosaic history, will be corroborated by a mass of internal evidence brought forward in succeeding parts of our inquiry.

Gradual deviation from simplicity.

The Arabic tongue, originally pure Hebrew, was in process of time greatly transformed and altered from its simple unsophisticated state. The Arabians were divided into many different tribes, a circumstance which naturally produced many different dialects. These, however, were by no means of foreign growth. No foreign enemy ever conquered these independent hordes. The Persians, Greeks, and Romans, sometimes attempted to invade their territories; but the roughness of the ground and the scarcity of forage, the penury of water and their natural bravery, always protected them. They were indeed once invaded by the Abyssinians or Ethiopians with some show of success; but these invaders were in a short time expelled the country. Their language, of consequence, was never adulterated with foreign words or exotic phrases and idioms. Whatever augmentations or improvements it received were derived from the genius and industry of the natives, and not from adventitious or imported acquisitions. From this circumstance we may justly infer, that the Arabian tongue was a long time stationary, and of course differed in no considerable degree from its Hebrew archetype. The learned Schultens, in his Commentary on Job, has shown, to the conviction of every candid inquirer, that it is impossible to understand that sublime composition without having recourse to the Arabic idioms. That patriarch was a Chuzite, and his country might be reckoned a part of Arabia. His three friends were actually Arabians, being the descendants of Ishmael and Esau. His country bordered on that of the predatory Chaldeans, who were an Arabian banditti. Hence, when we consider all these circumstances *in cumulo*, we are strongly inclined to believe that the book of Job was actually written in Arabic, as the language stood at that period; which, according to the most probable opinion, could not have been later than the age of Moses. The learned are generally agreed that this whole book, the three first chapters excepted, is a poetical composition, replete with the most brilliant and magnificent imagery, the boldest, the justest, and most gorgeous tropes and allusions, and a grandeur of sentiment wholly divine. Whoever has read with any degree of taste, the poetical compositions of the modern Arabians, on divine subjects, will, we flatter ourselves, discover a striking similarity both of diction and sentiment. Be this as it may, we think there is no reason to conclude that the Arabic dialect deviated much from the Hebrew standard prior to the Christian era.

Principal dialects of Arabia.

Of those different dialects which prevailed amongst the various tribes amongst which the peninsula of Arabia was divided, the principal were the Hemyaret and the Koreish. Though some of these were tributary to the Tobbas, or Hemyaret sovereign of Arabia Felix, yet they took no great pains to cultivate the language of that province, and of course these people did not thoroughly understand it. As for the independent tribes, they had no temptation to cultivate any other language than their own.

Dialect of the Koreish.

The Koreish tribe was the noblest and the most learned of all the western Arabs; and the kaaba, or square temple of Mecca, was prior to the era of Mohammed solely under their protection. This temple drew annually a great concourse of pilgrims from every Arabian tribe, and indeed from every other country where the Sabian religion prevailed. The language of the Koreish was studied with emulation by almost all the neighbouring tribes. Numbers of the pilgrims were people of the first rank, and possessed all the science peculiar to their country and their age. Great fairs were held during their residence at Mecca, and a variety of gay amusements filled up the intervals of their religious duties. In these entertainments literary compositions bore the highest and most distinguished rank; every man of genius considering not his own reputation alone, but even that of his nation or his tribe, as interested in his success. Poetry and rhetoric were chiefly esteemed and admired; the former being looked upon as highly ornamental, and the latter as a necessary accomplishment in the education of every leading man. An assembly at a place called Ocadh, had been in consequence established about the end of the sixth century, where all were admitted to a rivalship of genius. The merits of their respective productions were impartially determined by the assembly at large, and the most improved of their poems, written on silk, in characters of gold, were with much solemnity suspended in the temple, as the highest mark of honour which could be conferred on literary merit. These poems were called the *Moallabat*, suspended, or *Modhabebat*, golden. Seven of these are still preserved in European libraries.

From this uncommon attention to promote emulation and refine their language, the dialect of the Koreish became the purest, the richest, and the most polite, of all the Arabian idioms. It was studied with a kind of predilection; and about the beginning of the seventh century it was the general language of Arabia, the other dialects being either incorporated with it, or sliding gradually into disuse. By this singular idiomatic union, the Arabic has acquired a prodigious fecundity; whilst the luxuriance of synonymes, and the equivocal or opposite senses of the same or similar words, have furnished their writers with a wonderful power of indulging, in the fullest range, their favourite passion for antithesis and quaint allusion. One instance of this we have in the word *veli*, which signifies a prince, a friend, and also a slave. This same word, with the change of one letter only, becomes *vali*, which, without equivocation, imports a sovereign. Examples of this kind occur in almost every page of every Arabic dictionary.

Superiority of this dialect modern.

But all these advantages of this incomparable language are merely modern, and do not reach higher than the beginning of the sixth century. Prior to that era, as we have

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observed above, a variety of dialects obtained; and as the Arabs were by their situation in a manner sequestered from all the rest of mankind, it may not perhaps be superfluous to inquire briefly into the cause and origin of this instantaneous and universal change.

During a course of more than twenty centuries, the Arabians had been shut up within the narrow limits of their own peninsula, and in a great measure secluded from the rest of the world. Their commerce with India was purely mercantile, and little calculated to excite or promote intellectual improvements. They traded with the Egyptians from time immemorial; but since the invasion and usurpation of the pastor kings, every shepherd, that is, every Arabian, was an abomination to the Egyptians. From that quarter, therefore, they could not derive much intellectual improvement. Besides, when an extensive territory is parcelled out amongst a number of petty septs or clans, the feuds and contests which originate from interfering interests and territorial disputes, leave but little time, and less inclination, for the culture of the mind. In these circumstances, the military art alone will be cultivated, and the profession of arms alone will be deemed honourable. Of consequence, we find that, in the general opinion, poetry, rhetoric, and the profession of arms, were the only pursuits cultivated by the people in question. As for the science of war, we are convinced that it was both studied and practised at a very early period; but with regard to the two former, we imagine they were very late acquisitions, and sprung from some circumstance external and adventitious.

The tribe of the Koreish were much engaged in commerce. They exported frankincense, myrrh, cassia, galbanum, and other drugs and spices, to Damascus, Tripoli, Palmyra, and other commercial cities of Syria and its neighbourhood. Upon these occasions the Arabian traders must have become acquainted with the Greek language, and perhaps with the more amusing and affecting parts of the Grecian literature. They might hear of the high renown of Homer and Demosthenes; and it is not impossible that some of them might be able to read their compositions. Every body knows with what unremitting ardour the learned Arabs under the first caliphs, perused and translated the philosophical works of the Grecian sages. The very same spirit might animate their predecessors, although they wanted learning, and perhaps public encouragement, to arouse their exertions. From this quarter, we think, the Arabs may have learned to admire, and then to imitate, the Grecian worthies.

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The Ptolemies of Egypt were the professed patrons of commerce as well as of learning. Under these princes all nations were invited to trade with that happy country. The Arabs, now no longer fettered by Egyptian jealousy, carried their precious commodities to Alexandria, where the Grecian literature, though no longer in its meridian splendour, shone however with a clear unfaded lustre. The court of the first Ptolemies was the retreat of all the most celebrated geniuses of Greece and of the age; in a word, Alexandria was the native land of learning and ingenuity. Here the ingenious Arab must have heard the praises of learning incessantly proclaimed, and must have often been present at the public exhibitions of the poets and orators; and even although he did not exactly understand them, he might be charmed with the melody of the diction, and struck with surprise at their effects on the audience. The reader will please to reflect, that the Arabian traders were the first men of the nation, with respect to birth, learning, and fortune. These wise men, to use the language of Scripture, inspired with the natural curiosity of their race, might hear of the celebrated Olympic games, the public recitations before the people there assembled, and the glorious prize bestowed upon the conquerors. Such information might animate them to institute something parallel at Mecca, with a view to improve their language, and at the same time to derive honour and emolument to themselves. The Koreishim might promise themselves the like advantages from the establishment of the fair and assembly at Ocadh, as the natives of Elis derived from the institution of the Olympic games. For these reasons, we conjecture, the literary competitions at the place just mentioned were instituted at so late a period, although the nation had existed more than two thousand years before the establishment of this anniversary. Upon the whole, we are inclined to believe, that the Arabs, notwithstanding all the fine things recorded of them by their own poetical historians, and believed perhaps too easily by those of other countries, were in the days of ignorance like the earliest Romans, *latrones et semibarbari.* For our part, we think it by no means probable, that a people of that character should, after so long a course of years, have stumbled upon so laudable and so beneficial an institution, without taking the hint from some foreign one of a similar kind. This we acknowledge is only a conjecture, and as such it is submitted to the judgment of the reader.

Arabic
Language.

There were, as has been observed above, two principal dialects of the original Arabic: the Hamyarite, spoken by the genuine Arabs; and the Koreishite, or pure Arabic, which at last became the general language of that people. The former of these inclined towards the Syriac or Chaldaic; the latter being, according to them, the language of Ishmael, was deeply tinctured with the Hebrew idiom. The oriental writers tell us that Terah, the grandfather of Hamyar, was the first whose language deviated from the Syriac to the Arabic. Hence, say they, the Hamyaritic dialect must have approached near to the purity of the Syriac, and consequently must have been more remote from the true genius of the Arabic than that of any of the other tribes. The fact seems to stand thus: The Hamyarites were neighbours to the Chaldeans and Syrians, and consequently were connected with those people by commerce, wars, alliances, and other kinds of intercourse. This circumstance introduced into their language many phrases and idioms from both these nations. That Terah was concerned in adulterating the dialect of the Hamyarites, is a mere oriental legend, fabricated by the Arabs, after they began to peruse the Hebrew Scriptures. The Koreish being situated in the centre of Arabia, were less exposed to intercourse with foreigners, and therefore preserved their language more pure and untainted.

The Koran
written in
the Koreish
dialect.

The learned well know, that the Koran was written in the dialect of the Koreish, a circumstance which communicated additional splendour to that branch of the Arabian tongue. It has been proved, that the language of the original inhabitants of Arabia was genuine Hebrew. But upon this supposition a question will arise, namely, whether the Arabians actually preserved their original tongue pure and unsophisticated during a space of about three thousand years, which elapsed between the deluge and birth of Mohammed; or whether, during that period, according to the ordinary course of human affairs, it underwent many changes and deviations from the original standard.

The admirers of that language strenuously maintain the former position; others, who are more moderate in their attachment, are disposed to admit the latter. Chardin observes of the oriental languages in general, that they do not vary and fluctuate with time like the European tongues.[1] " Ce qu'il y a de plus admirable, dit il, et de plus remarquable, dans ces langues, c'est, qu'elles ne changent point, et n'ont point changé du tout, soit à l'égard de termes, soit à l'égard du tour: rien n'y est, ni nouveau ni vieux, nulle bonne façon de parler n'a cessé d'être en credit. L'Alcoran, par exemple, est aujourdhui, comme il y a mille années, le

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[1] *Voyages,* vol. iii. p. 43.

modèle de la plus pure, plus courte, et plus eloquente diction." It is not to our purpose to transcribe the remaining part of the author's reflection upon this subject. From the above it plainly appears that he concludes, that the Arabian tongue has suffered no change since the publication of the Koran; and at the same time insinuates, that it had continued invariable in its original purity through all ages, from the days of Kobtan to the appearance of that book. Whether both or either of these sentiments be properly authenticated will appear in the sequel.

Means adopted by the Arabs to preserve the purity of their language.

The learned Dr. Robertson, professor of oriental languages in the university of Edinburgh, informs us that the Arabians, in order to preserve the purity of their language, strictly prohibited their merchants, who were obliged to go abroad for the sake of commerce, all intercourse with strange women. We know not where this injunction is recorded, but certainly it was a most terrible interdict to an amorous son of the desert. If such a prohibition actually existed, we suspect it originated from some other source than the fear of corrupting their language. Be this as it may, however, the Doctor, as well as the great Schultens, is clearly of opinion that the language in question, although divided into a great number of streams and canals, still flowed pure and limpid in its course.

The style of the Koran now obsolete.

Our readers who are acquainted with the history of the orientals, are already apprised of the steady attachment of those people to ancient customs and institutions. We readily allow, that in the article of language this same predilection is abundantly obvious; but every oriental scholar must confess, that the style of the Koran is at the present day in a manner obsolete, and has become almost a dead language. This fact, we believe, will not be questioned. If the Arabian has deviated so very considerably from the standard of the Koran in little more than one thousand years, and that too after an archetype is ascertained, we may by a parity of reason infer, that much greater deviations must have affected the language in the space of three thousand years. It is universally allowed by such as maintain the unsullied purity of the Arabian tongue, that it was originally the same with the Hebrew, or, in other words, with the ancient Syriac and Chaldaic. Let any one now compare the words, idioms, and phraseology of the Koran with the remains of those three languages, and we think we may venture to affirm that the difference will be palpable. This circumstance, we think, indicates in the strongest terms a remarkable alteration.

The Arabs themselves are agreed, that notwithstanding the amazing fecundity of their language, vast numbers of its radical terms have been irrecoverably lost. But this loss could not be supplied without either fabricating new words, or borrowing them from foreign languages. To the latter method we have seen their aversion, and must therefore conclude that they adopted the former. The Chaldeans, Syrians, and Phœnicians, had made innovations on their language at a very early period, even before conquests were undertaken; and we see no reason to suppose that the Arabs did not innovate as well as their nearest neighbours.

It resembles the Hebrew in its phraseology.

There are, we think, very strong reasons to believe, that Job was an Arabian, and flourished prior to Moses, perhaps as early as Jacob. The style, the genius, and the figurative tone of the composition; the amazing sublimity of the sentiments, the allusions, the pathos, the boldness, the variety and irregularity, and the poetical enthusiasm which pervade the whole poem, strongly breathe the Arabian spirit; indeed the very diction is peculiar to that single book, and differs widely from that of the Psalms and every poetical part of the sacred canon. If we compare this book with Mohammed's Koran, we shall scarcely find any resemblance of words or phraseology, but a wonderful similarity of figures, enthusiasm, and elevation of sentiments. We are then led to conclude, that the Arabic did actually lose and gain a multitude of vocables between the era of its first establishment amongst the descendants of Joktan and Ishmael, and the birth of the impostor.

The art of writing was introduced amongst the Arabs at a very late period. Without the assistance of this art, one would think it altogether impossible to preserve any language in its primæval purity and simplicity. As the curious reader may here expect some account of the Arabic characters: the following detail is the most probable one we have been able to collect on the subject.

Art of writing amongst Hamyarites.

It is generally agreed, that the art of writing was known amongst the Hamyarites or Homerites at a very early period.[1] These people were sovereigns of Arabia during a course of many years. The character of their graphic system was somewhat perplexed and confused. It was called *al Mosnad*, from the mutual connection of the letters. The alphabet of these people resembled that of the Hebrews both in the number and order of the letters, and was called *abgad heviz*,[2] from the first ten letters of the Hebrew alphabet, artificially thrown together. "And this word," says the learned Chardin[3] "*a*, *b*, *g*, *d*, is formed of the four letters which were heretofore the first in the Arabian language, as they are still in that of the Hebrews." The same traveller is positive that these were the ancient characters of the Arabs; that they differed from the Cuphic letters, which were afterwards introduced; and that they were also furnished with vowel points. These, we imagine, were the first sketches of the Chaldaic characters, which probably the Hamyarites retained in their pristine unpolished form, after they had been polished and reduced to a more elegant size by the original inventors.

Monuments bearing inscriptions in these characters are, they tell us, still to be seen in several places of Arabia. Some were engraved upon rocks; and to these we think it probable that the patriarch Job alludes in those passages where he seems to intimate an inclination to have his sufferings recorded in a book, and graven in the rock for ever. All the Arabians agree, that the dialect of the Hamyarites inclined towards the Syriac or Chaldaic. This we have imputed to the connection of that people with the Chaldeans, who lived in their neighbourhood. If the Hamyaritic dialect was infected with the Syriac or Chaldaic, there can be no doubt that they derived their letters from the same quarter.

We conclude, then, that the Hamyarites knew the art of writing from the earliest antiquity, and that the letters they employed were the rude Chaldaic in their unimproved state.[4] Some of the Arabians do indeed hold, that Ishmael was the first author of letters, but that his characters were rude and indistinct, without any interval between letters or words, and that these were adopted by Kedar and his other children. This tradition, however, has met with little credit.

Art of writing amongst Koreishites.

With respect to the highly polished Koreishites, it is agreed on all hands, that they were unacquainted with the use of letters until a few years before the birth of Mahommed. But two difficulties here present themselves. The first is, how the Koreishite dialect, without the art of writing, happened to excel all the other dialects of the Arabic tongue, assisted by that art, which is apparently so necessary for preserving a language in its original purity. The second is, we think, still greater, namely, how the Koreish came to learn that most useful art at so late a period as the sixth century. It is a well known fact, that ever after the Babylonian captivity Arabia swarmed with Jewish villages, in

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[1] Pococke's *Specim. Hist. Arab.*

[2] Id. *ibid.*

[3] Vol. iii. p. 153.

[4] Pococke, *Orat. de Ling. Arab.*

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which the art of writing was generally known; and almost at the beginning of the Christian era, multitudes of Christians retired to the same country, in order to avoid the persecutions which they suffered in the Roman empire. In these circumstances, we think it rather strange, that the Koreishites, highly polished and acute as they were, never thought of embracing the opportunity of learning an art so useful. These two problems we leave to be solved by our more learned readers.

But however they be solved, it is universally acknowledged, that the Koreish were ignorant of letters till a few years before the birth of their prophet. Ebn Chalican,[1] one of their most celebrated historians, informs us, that Moramer the son of Morra, an Anbarian, or native of Anbaris, a city of Irak,[2] first invented alphabetical characters, and taught his countrymen to use them, and that from the latter this noble invention was derived by the Koreishites. These letters, though neither beautiful nor convenient, were long used by the Arabs. They were denominated *Cuphic*, from Cupha, a city of Irak. In these characters the original copy of the Koran was written. They were probably the original clumsy characters which were retained by the vulgar, after the beautiful square Chaldaic letters had been invented, and probably used by priests, philosophers, and the learned in general. These letters are often at this day used by the Arabs for the titles of books and public inscriptions.

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Abauli the son of Mocla,[3] about three hundred years after the death of Mohammed, found out a more elegant and more expeditious character. This invention of Abauli was afterwards carried to perfection by Ebn Bowla, who died in the year of the Hegira 413, when Kader was caliph of Bagdad. This character, with little variation, obtains at the present day. As we think this article of some importance, we shall, for the sake of our unlearned readers, transcribe an excellent account of the whole matter from the very learned Schultens.

The Cuphic character, says he, which had been brought from the region of the Chaldeans to the province of Hejaz, and to Mecca its capital, in the age of Mohammed, was employed by the Koreishites, and in it the Koran was first written. But as this character was rude and clumsy, in consequence of its size, and ill calculated for expedition, Abauli Ebn Mocla devised a more elegant and expeditious one. This person was visir to Arradius, the forty-first caliph, who began to reign in the year of the Hegira 322. Accordingly, in the tenth century, under this emperor of the Saracens, the form of the Arabian alphabet underwent a change; and the former clumsy embarrassed character was made to give way to the polished, easy, and expeditious type. Regarding this expedition alone, the author of the invention left very few vowel characters; and as the Hebrew manner of writing admits five long ones and five short in different shapes, he taught how to express all the vowels, both long and short, suitably to the genius of the language, by three, or rather by two, small points, without any danger of a mistake, an abbreviation truly deserving applause and admiration; for by placing a very small line above بَ he expressed *a*, and *e*; and by placing the same below بِ he meant to intimate *i* only. To the other short ones, *o* and *u*, he assigned a small *waw* above. In order to represent the long ones, he called in the *matres lectionis*, the "quiescent letters א, ו, י;" so that *phata* with *elif* intimated *a* and *o* long, that is, *kametz* and *cholem*; *jod* placed after *kefram* became *tzeri* and *chirek* long. *Waw* annexed to *damma* made *schurek*.

In this passage, the great orientalist acknowledges that the visir above mentioned, who carried the Arabian alphabet to the pinnacle of perfection, invented and annexed the vowel points for the sake of ease and expedition in writing; from which we may infer, that prior to the tenth century the Arabians had no vowel points, and consequently either read without vowels, or contented themselves with the *matres lectionis* above mentioned.

Arabic
Language.

The design of the author of the invention, in fabricating these points, was confessedly ease and expedition in writing; a circumstance which furnishes a strong presumption that the Hebrew vowel-points were devised and annexed at some late period for the very same purposes. Some, indeed, have gone so far as to affirm that the Arabians were the original fabricators of the vowel-points. "The Arabians,"[4] says the learned Dr. Gregory Sharp, "were the original authors of the vowel-points. They invented three, called *fatha*, and *damma*, and *kefra*; but these were not in use till several years after Mohammed; for it is certain that the first copies of the Koran were without them. The rabbis stole them from the Arabs." This, however, is carrying the matter too far, since it is certain that the Jews were acquainted with the points in question long before the period above mentioned.

Extent of
the Arabic
language.

Though it is not our intention to enter into a minute detail of the peculiarities of this noble language, we cannot omit observing one thing, which indeed belongs to grammar, but is not generally taken notice of by the Arabic grammarians. The roots of verbs in this dialect are universally triliteral; so that the composition of the twenty-eight Arabian letters would give near twenty-two thousand elements of the language. This circumstance demonstrates the surprising extent of it. For although great numbers of its roots are irrecoverably lost, and some perhaps were never in use; yet if, without reckoning quadriliterals, we suppose ten thousand of them to exist, and each of them to admit only five variations, one with another, in forming derivative nouns, the whole language would then consist of fifty thousand words, each of which may receive a multitude of changes by the rules of grammar.

Again, the Arabic idiom seems to abhor the composition of words, and invariably expresses very complex ideas by circumlocution; so that if a compound word be found in any dialect of that language, we may at once pronounce it of foreign extraction. This is indeed a distinguishing feature in the structure of the Arabic, as well as in that of some of its sister dialects, and has, in our opinion, contributed not a little to the amazing fecundity of that language; for since every ingredient in the composition of a complex idea requires a word to express it, as many words became necessary to complete the language as there were simple ideas to be intimated by discourse. Were all the compounds of the Greek language to be dissolved, as probably once they were, the vocables of that tongue would infinitely exceed their present number.

The Arabic authors boast most unconscionably of the richness and variety of their language. No human understanding, say they, is capacious enough to comprehend all its treasures. Inspiration alone can qualify one for exhausting its sources.[5] Ebn Chalawalb, a most renowned grammarian of theirs, has spent a whole volume upon the various names of the lion, which amount to five hundred; and another on the names of the serpent, which make up two hundred. Mohammed al Firancabodius affirms that he wrote a book on the usefulness and different denominations of honey, in which he enumerates eighty of them; and after all, he assures us that he was still far from having exhausted his subject. To excel in a language so amazingly copious, was certainly a proof of uncommon capacity, and considered as no mean talent even amongst the Koreishites. Hence Mohammed, when some people were expressing their admiration of the eloquence of the Koran, told them that he had been taught by the angel Gabriel the language of Ishmael, which had fallen into desuetude.

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[1] See this whole detail in Dr. Pococke's *Specim. Hist. Arab.* p. 250. *et seq.*

[2] *Irak*, Babylonia, from *Erech* one of the cities built by Nimrod. The Arabians have generally restored the ancient names of places. Thus with them Tyre is *Tzur*, Sidon *Seyd*, Egypt *Mezri*, &c.

[3] Robertson, *Clavis Pentateuch.* pp. 35, 36.

[4] *Dissertation on the Origin of Languages.*

[5] Pococke's *Specim.*

Oratory and poetry of the Arabs.

In a language so richly replenished with the choicest and most energetic terms, both oratory and poetry were cultivated with ease. All the difficulty consisted in making a choice amongst words and phrases equally elegant. We may compare one of those poets or orators to a young gentleman, of a taste highly refined, walking into a repository where a profusion of the richest and most elegant dresses are piled up in wild confusion. The beau is here distressed with variety; but to be able to choose the most handsome and most becoming, he must have received from nature a superior good taste, and must likewise have cultivated it by assiduous industry, and by associating with the most genteel company.

The orations of the Arabians were of two kinds, metrical and prosaic. The former they compared to pearls set in gold, and the latter to loose ones. They were ambitious of excelling in both; and whoever did so, was highly distinguished. His success in either of those departments was thought to confer honour, not only on his family, but even on his tribe. In their poems were preserved the genealogies of their families, the privileges of their tribes, the memory of their heroes, the exploits of their ancestors, the propriety of their language, the magnificence of banquets, the generosity of their wealthy chiefs and great men, &c. After all, we cannot avoid being of the unpopular opinion, that this mighty parade of eloquence and poetry did not reach backwards above two centuries before the birth of Mohammed, as it certainly vanished at the era of the propagation of his religious institutions. The two succeeding centuries were the reigns of superstition and bloodshed. The voice of the muses is seldom heard amidst the din of arms.

The ancient Arabs, at whatever time poetry began to be in request amongst them, did not at first write poems of considerable length. They only expressed themselves in metre occasionally, in acute rather than harmonious strains. The Proverbs of Solomon, and the book of Ecclesiastes, seem to have been composed in this species of versification. The prosody of the Arabs was never digested into rules till some time after the death of Mohammed; and this is said to have been done by Al Khalti al Farabidi, who lived in the reign of the caliph Haroun al Raschid.

After so many encomiums on the copiousness of the Arabic tongue, one class of our readers may possibly expect that we should subjoin a brief detail of its genius and character; and this we shall do with all possible brevity.

Genius and character of the language.

All the primary or radical words of the language are composed of different combinations of consonants by *triads;* so that the various combinations and conjunctions of radicals make more than ten thousand, even without including those which may arise from the meeting of gutteral letters. From this quality of the language has flowed that stability of the dialect which has preserved it pure and entire for so many thousand years, and secured it from those changes and that fluctuation to which most other tongues are subject.

Perhaps notwithstanding its copiousness and variety, no other language can vie with the one in question in point of perspicuity and precision. It is possessed of a brevity and rotundity which, amidst the greatest variety, enables it to express with clearness and energy what could not be expressed in any other tongue without tedious circumlocutions. To this purpose we shall beg leave to transcribe a passage from Bishop Pococke's oration on the Arabic language. As we imagine that few of those readers who will have the curiosity to peruse this article can be unacquainted with the Latin tongue, we shall give it as it stands in the original without a translation:—

"Neque in nulla certe laudis parte, mira illa qua, non solum verborum in significando, perspicuitate, sed in prolatione, elegantiæ et dulcedini caverunt, sedulitas; quoque, non solum accurata, inter literas ex significata proportione, sensus vel intensione, vel remissione, prout res postulaverit, literarum appositione, subductione, vel juxta organorum, rationem prospexerunt; sed et ne quid delicatulis auribus ingratum, ne quid horridum, aut ἀσυμφωνον, reperiatur, effecerunt. Hoc in genere est, quod nuspiam in verbo aliquo, genuinæ apud Arabes originis, concurrunt, non intercedente vocalis alicujus motione consonantes, cum vel tres, vel plures, aliis in linguis frequenter collidantur. Immo neque, si adsint, quæ asperitati remedio sint, vocales, quas libet temere tamen committunt consonantes; sed ita rei natura postulat, ut concurrere debeant illa, quæ se invicem, sine asperitatis inductione consequi, et inter se connecti non possint; illi vel situs, vel literarum mutatione, eas abjiciendo, inserendo, emolliendo, aliisve quibus possent modis, remedia quærunt; adeo ab omni, quod vel absonum, vel dissonum est, abhorrent. Quod si nobis secus videntur, et asperius sonare ab Arabibus prolata, illud auribus nostris, et usui, non linguæ imputandum, nec mollius illis sonare nostra, quam eorum nobis censendum. Quin et gutturalium, quæ nobis maxima asperitatis causa videntur, absentiam, ut magnum in lingua Græca defectum, arguunt Arabes."

The learned Dr. Hunt, professor of the Hebrew and Arabic languages at Oxford, was of the same opinion with the very learned prelate, part of whose oration we have transcribed above, with respect to the delicacy and elegance of the Arabian language: "Nusquam, mihi credite, inquit ille, auribus magis parcitur quam in Arabia; nulla lingua a κακοφωνια, alienior quam Arabica. Quamquam enim nonnullæ ejus literæ minus fortasse suaviter, immo durius etiam sonuerint, ita tamen Arabes eas temperarunt cum lenibus, duras cum mollibus, graves cum acutis miscendo, voces inde non minus auribus jucundæ, quam pronunciatu faciles confecerint, totique sermoni miram sonorum tam dulcedinem quam varietatem addiderint. Quod quidem orationis modulandæ studium in Corano adeo manifestum est, ut primi Islamismi oppugnatores eum librum magica ideo arte scriptum dixerint. Non auribus tantum gratus est Arabismus, sed et animi conceptibus exprimendis aptus, sonos suos sententiis semper accommodans, et felici verborum junctura eorum naturam depingens."

To these we might add quotations from Erpenius's oration on the same subject, from Golius, Schultens, Hottinger, Bochart, and Sir William Jones; besides a whole cloud of oriental witnesses, whose extravagant encomiums would astonish rather than edify the greater part of our readers. These panegyrics may perhaps be in some measure hyperbolical; but in general we believe them to be pretty well founded. At the same time we are convinced that the Arabic, however melodious in the ears of a native, sounds harsh and unharmonious in that of an European.

Difficulty of acquiring a knowledge of it.

When we consider the richness and variety of the Arabic tongue we are led to conclude, that to acquire a tolerable degree of skill in its idioms, is a more difficult task than is generally imagined; at least some people who have with facility enough acquired a knowledge of the Greek and Latin, and likewise of the more fashionable modern languages have found it so. Be this as it may, however, there are two classes of men who, in our opinion, cannot handsomely dispense with the knowledge of a tongue almost universal; the gentleman, who is to be employed in the political transactions of the most respectable mercantile company upon earth, in the eastern parts of the world; and the divine, who applies himself to investigate the true import of the sacred oracles. Without this, the former will often find himself embarrassed in both his civil and mercantile negociations; and the latter will often grope in the dark, when a moderate acquaintance with that tongue would make all sunshine around him.

haldaic
nguage,
&c.

Bochart, Hottinger, Schultens, Pococke, Hunt, Robertson, and others, have taken wonderful pains, and lavished a profusion of learning, in proving the affinity and dialectical cognation between the Hebrew and Arabic. Much of this labour, we think, might have been spared. We presume to affirm, that no person tolerably versed in both languages can read a single paragraph of the Arabic version of the New Testament, or indeed of the Koran itself, without being convinced of the truth of this position. It is but stripping the latter of its adventitious frippery, and the kindred features will immediately appear.

The learned professors of the university of Leyden were the first who entered upon the career of Arabian learning. To them the European students are principally indebted for what knowledge of that language they have hitherto been able to attain. Though several Italians have contributed their endeavours, yet the fruit of their labours has been rendered almost useless by more commodious and more accurate works printed in Holland.

The palm of glory, in this branch of literature, is due to Golius, whose works are equally profound and elegant; so perspicuous in method, that they may always be consulted without fatigue, and read without languor. Erpenius's excellent grammar, and his memorable dictionary, will enable the student to explain the history of *Timur* by Ibn Arabshah. If he has once mastered that sublime work, he will understand the learned Arabic better than most of the Khatabs of Constantinople or of Mecca.

The Arabian language, however, notwithstanding all its boasted perfections, has undoubtedly shared the fate of other living languages; it has gradually undergone such considerable alterations, that the Arabic spoken and written in the age of Mohammed may be now regarded as a dead language. It is indeed so widely different from the modern language of Arabia, that it is taught and studied in the college of Mecca just as the Latin is at Rome.

The dialect of the Highlands of Yemen is said to have the nearest analogy to the language of the Koran, because these Highlanders have little intercourse with strangers. The old Arabic is throughout all the east, like the Latin in Europe, a learned tongue, taught in colleges, and only to be acquired by the perusal of the best authors.

SECT. III. OF THE CHALDAIC, PHŒNICIAN, AND EGYPTIAN LANGUAGES.

C nexion
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la uages.

As there is a very strict connection and dialectical analogy amongst these languages, we have arranged them all under one section; especially since what is observed relating to one of them may, without the least straining, be extended to them all. We shall begin with the Chaldaic.

The Chaldeans, or Chasidim, as they are always called in Scripture, were the descendants of Chesed the son of Nahor, the brother of Abraham. The descendants of this patriarch drove the Cushim or Arabians out of Babylonia, and possessed themselves of that country at a very early period. As these Chasidim or Chaldeans were the posterity of Nahor, the descendant of Heber, they undoubtedly spoke the original Hebrew tongue as well as the other branches of that family. But being an ingenious and inventive people, they seem to have polished their language with much care and delicacy of taste.

The only genuine remains of the ancient Chaldaic language are to be found in the Hebrew Scriptures; and these are contained in two hundred and sixty-eight verses, of which we have two hundred in Daniel, reaching from verse 4th, chapter 2d, to chapter 8th exclusive; in Ezra sixty-seven, viz. in chapter 4th, seventeen verses, in chapter 5th, the same number, in chapter 6th, eighteen verses, and in chapter 7th, fifteen; in Jeremiah, chapter 10th, there is extant only one verse. From these fragments, compared with the Hebrew, it plainly appears, that the difference between that language and the Chaldaic is scarcely equal to that between the Doric and Ionic dialects of the Greek.

Chaldaic
Language,
&c.

Whatever might have been the form of the most ancient Chaldaic letters, it is generally known that the beautiful square characters, in which the Hebrew Scriptures began to be written after the age of Ezra, were current amongst them at an era prior to the Babylonian captivity. Those elegant characters were probably the invention of the Chaldean academies, which were established in various parts of that extensive and fertile country.

Chaldaic
differs little
from the
Hebrew.

The Chaldean declensions and conjugations differ so little from the Hebrew modifications, that it would be almost superfluous to dwell upon them in this section. The most effectual way to acquire an idea of the ancient Chaldaic, is to decompose the names confessedly of that dialect, which occur in many places of Scripture. By this method of proceeding, its beautiful structure and expressive energy will be readily comprehended even by the most illiterate class of readers. At the same time, we must observe, that the Chaldaic and the ancient Syriac bore so near a resemblance to each other, that they have generally been classed under one head.

The first Chaldaic word which occurs in the Old Testament is BARA, *creavit*. This word has all along been assigned to the language under consideration; for what reason, we confess we are not able to discover. The greater part of the Hebrew tongue is now lost. The words BAR, *a son*, and BARA, *creavit*, or rather *filiavit*, may probably be of that number. Another Scriptural word which is often quoted, and always ascribed either to the Syriac or Chaldaic, is *igar* or *jegar sahadutha*, which signifies a mountain of witnesses. Every body knows, that when Jacob and Laban made their compact, the latter denominated the heap of stones reared upon that occasion in this manner; whilst the former called it *Galeed*, as we now write and pronounce it. This pronunciation, however, does not appear to us altogether genuine. The word is probably compounded of גל, *gal*, *cumulus*, a heap, and עד, *chad*, *æternitas*, *seculum*, eternity, an age; so that גלעד, *galchad*, or *galaad* as it came to be written afterwards, signified an everlasting heap. Laban then had respect to the end for which the monument was erected; but Jacob alluded to its duration. It appears, however, upon this and every other occasion, when Chaldaic words are mentioned, that א, *a*, was a favourite letter both with the Syrians and Chaldeans. We may likewise observe, that the same people always changed the Hebrew ש, *shin*, into ת, *thau*, in order to avoid the serpentine sound of that consonant.

Its proper
names pure
Hebrew.

The Chaldaic names of gods, men, places, &c. which occur in Scripture, appear to be no other than Hebrew polished and improved. *Bel*, *Belus* in Latin, is evidently בעל, *Baal*, or we think rather ב-על, *Bechel*. The Phœnicians, and sometimes the Hebrews, used it to signify the Most High. The Chaldeans used their word *Bel* for the same purpose; and because this word originally imported the High One, they dignified their first monarch with that name. They denominated their capital city *Ba-Bel*, which imports the Temple of Bel, and afterwards *Babylon*, which intimates the abode or dwelling of our lord the sun. *Nebo* was a name of the moon amongst the Babylonians, being derived from the Hebrew נבא, *nabah*, *vaticinari*, to prophecy. *Azer* was the planet Mars, from אצר, *Azer* or *Ezur*, *accinxit*, to gird, alluding to the girding on of arms. *Ahad* was an Assyrian name of the sun,[1] being a word deduced from the Hebrew אעד *ahad*, *unus*, one. *Netzur* was the name of an Arabian idol,[2] which often occurs in the composition of Babylonian names. In Arabic it signifies an eagle. We think, however, that the word is the Hebrew נצר, *natzar*, *custodivit*, *servavit*, to keep, to preserve. To these names of deities many more might be added, which the nature of our design will not allow us to mention.

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[1] *Merob.* lib. i. c. 23.

[2] Pococke, *Specim. Hist. Arab.*

Almost all the Chaldean proper names which occur either in sacred or profane history are evidently of Hebrew original, or cognate with that language. We shall subjoin a few examples. *Nabonassar* is evidently compounded of *Nabo* and *nazur*, both Hebrew words. *Nabopollazar* is made up of *Nabo-Pul*, the same with *Bel*, and *Azer* or *Azor*, above explained. *Belesis* is made of *Bel* and אשא, *Esha*, signifying fire. Nebuchadnezzar, Belshazzar, Belteshazzar, Neriglissar, Nebuzaradan, Rabmag, Rabsaris, Nergal Sharezer, Rabshakeh, Ezarhaddon, Merodach, Evil-Merodach, and numberless others, are so manifestly reducible to Hebrew vocables, when decomposed, that any oriental scholar will readily distinguish them.

Names of places in the Chaldaic are likewise so nearly akin to Hebrew, that nothing but the dialectical tone separates them. Thus *Ur* of the Chaldeans is actually אור, *light*, that city being sacred to the sun; *Sippora* is plainly the Hebrew word *Zipporah; Carchemish*, a city on the Euphrates, is evidently compounded of *Kir* or *Kar*, a city, and *Chemosh*, a name of the sun. In short, every Chaldaic or old Syriac word now extant, betray their Hebrew original without any difficulty. As for their dialectical differences, these may be discovered by consulting the Chaldaic grammars and lexicons.

Phœnician language derived from the Hebrew.

We now proceed to the consideration of the Phœnician language, which is known to have been that of the ancient Canaanites. That this was one of the original dialects, and consequently a cognate of the Hebrew, is universally acknowledged. Instead therefore of endeavouring to prove this position, we may refer our readers to the works of the learned Bochart, where that author has in a manner demonstrated this point, by deriving almost all the names of the Phœnician colonies from the Hebrew, upon the supposition that the dialect of those people was closely connected with that tongue. St. Augustin, in his treatise *de Civitate Dei*, has observed, that even in his time many of the vulgar in the neighbourhood of Carthage and Hippo spoke a dialect of the old Punic which nearly resembled the Hebrew. Procopius, *(de Bello Gothico)* informs us, that even in his days there existed in Africa a pillar with this inscription in Hebrew: "We flee from the face of Joshua the robber, the son of Nun." The names of all the ancient cities built by the Carthagenians upon the coast of Africa are easily reducible to a Hebrew original. The Carthagenian names of persons mentioned in the Greek and Latin history, such as Himilco, Hamilcar, Asdrubal, Hannibal, Hanno, Dido, Anno or Hanno, Sophonisba, Gisgo, Maherbal, Adherbal, and others, all indicate a Hebrew extraction.

The Greeks borrowed a great part of their religious worship from the people of whose language we are treating; and consequently, the names of most of their gods are Phœnician. Almost every one of these is actually Hebrew, as might easily be shown. The names of persons and places mentioned in the fragments of Sanchoniathon, preserved by Eusebius, are all of Hebrew complexion. The names mentioned in the Hebrew Scriptures of places which belonged to the Canaanites prior to the invasion of the Israelites under Joshua, are as much Hebrew as those which were afterwards substituted in their stead. The Punic scene in Plautus has been analysed by Bochart and several other learned men, by whom the language has been clearly proved to be deduced from the Hebrew, with some dialectical variations.

The island of Melita, now Malta, was inhabited by a colony of Phœnicians many ages before the Moors took possession of it. Amongst the vulgar of that island many Punic vocables are current to this day, all which may be readily traced up to the Hebrew source. To these we may add many inscriptions on stones, coins, medals, and the like, which are certainly Phœnician, and as certainly of Hebrew extraction. We have thrown together these few hints without pursuing them to any great length, as we deemed it unnecessary to dwell long on a point so hackneyed and so generally acknowledged.

Origin of the Ethiopians.

Before we proceed to treat of the ancient language of the Ethiopians, we find ourselves obliged to hazard a few strictures touching the origin of that ancient nation. If we can once settle that single point, the discovery will open an avenue to their primitive dialect, the point about which we are chiefly concerned in the present discussion.

In the section concerning the Hebrew language, we were led often to mention the patriarch Cush the eldest son of Ham. The posterity of this family chief, under his son Nimrod, possessed themselves of Shinar, which was afterwards denominated *Chaldæa*. These were probably the Arabians whose kings, according to Eusebius, Africanus, and other ancient chronologers, reigned in Babylon during several successive generations. They were the Cushim or Cushites, whom the learned Mr. Bryant has conducted over a great part of the world, and to whose industry and ingenuity he has ascribed almost all the inventions, arts, sciences, laws, policy, religions, and governments, which distinguished mankind in the earliest ages.

In process of time, the posterity of Chasid or Chesed, called *Chasdim* or *Chasidim*, in the east, and Chaldeans in the west, drove out the Cushim, and seized upon their country. The Cushim retired westward, and spread themselves over that part of Arabia situated towards the south-east. They probably extended themselves over all the eastern part of that peninsula, from the sea to the wilderness between Arabia and Syria, and they were the Ethiopians mentioned in Scripture, by a very unpardonable inadvertency of our translators. Such, then, in our opinion, were the primitive Cushim.

Josephus informs us, that all the Asiatics called the Ethiopians of Africa by the name of *Cushim*.[1] This denomination was not given them without good reason; it imports at least, that they were deemed the descendants of Cush, because it was the constant practice of the orientals in the early ages to denominate nations and tribes from the name of their great patriarch or founder. The name *Cushim* must then have been given to the Ethiopians, from a persuasion that they were the progeny of the son of Ham who bore that name. By what route, however, the Cushim penetrated into that region of Africa which was called by that name, it may be taken for granted that they were the descendants of Cush above mentioned.

It has been observed above, that the posterity of Cush possessed the country of Shinar or Chaldæa at a very early period, but were expelled by the Chasidim or Chaldeans. Upon this catastrophe, or perhaps somewhat later, a colony from the fugitive Cushim transported themselves from the south and south-east coast of Arabia over the sea which lies between that country and Ethiopia. However imperfect the art of navigation might be in that age, the distance was so small that they might easily enough make a voyage across that narrow sea in open boats, or perhaps in canoes. But however that may have been, it cannot be doubted that the tribes on both sides of that branch of the sea were kindred nations.

Their language originally Chaldaic.

If, then, both the northern and southern Cushim sprung from the same stock, there can be no doubt that both spoke the same language. The language of the Babylonian Cushim was Chaldaic, and consequently that of the Ethiopian

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[1] *Antiq. Judaic.* lib. i. c. 7.

Cushim was the same. We may therefore rest assured, that whatever changes the Ethiopian dialect may have undergone in the course of three thousand years, it was originally either Chaldaic, or at least a branch of that language. Scaliger informs us, that the Ethiopians call themselves Chaldeans; and this, says he, not without reason, because of the many sacred and profane books which are extant amongst them, the most elegant and most beautiful are written in a style resembling that of the Chaldean or Assyrian. Marianus Victorius, who was the first that reduced the Ethiopic tongue to the rules of grammar, tells us, in his *Proœmium*, that the Ethiopians call their tongue Chaldaic; that it springs from the Babylonian, and is very like the Hebrew, Syriac, and Arabic; and at the same time, he concludes, that this language may be easily learned by those who are masters of the Hebrew. The learned Bochart, and Bishop Walton in his *Prolegomena*, are clearly of the same opinion.

The vulgar letters of the Ethiopians, according to Diodorus Siculus, were the same with the sacred characters[1] of the Egyptians.[2] From this account, if the Sicilian may be trusted, the sacred letters of these people, concerning which so many vague conjectures have been formed, were actually Chaldaic. To carry on this investigation a little farther, we may observe, that Sir William Jones seems to have proved, by very plausible arguments, that the Sanscrit characters were deduced from the Chaldaic. This circumstance affords a presumption that the Ethiopian Cushim were likewise concerned with the Egyptians; who, as is remarked in the section concerning the *Sanscrit*, probably introduced the religion of the Brahmans into Hindostan. This is advanced as a conjecture only; and yet when we consider the affinity between the Egyptian and the Gentoo religions, we are strongly inclined to believe that this surmise may one day be verified by undeniable facts.

A ent in- te urse be een th Ethio- pi and E tians.

The original Ethiopians were a highly civilized people; and their laws, their institutions, and especially their religion, were celebrated far and wide. Homer talks in raptures of the piety of the Ethiopians, and sends his gods every now and then to revel twelve days with that devout people. The Sicilian produces a number of very specious arguments to prove that these two nations originally sprung from the same stock. He mentions a similarity of features, of manners, of customs, of laws, of letters, of the fabrication of statues, and of religion, as evidences of the relation between these two neighbouring nations. There was, as everybody knows, a communion, in regard to sacred rites, between the two countries. The Egyptians sent annually a deputation of their priests, furnished with the portable statues of their gods, to visit the fanes of the devout Ethiopians. Upon this occasion, a solemn religious banquet was prepared, which lasted twelve days, and of which the priests of both nations were partakers. It was a kind of sacramental institution, we imagine, by which both parties publicly avouched their agreement in the ceremonies of their religion respectively. These observations plainly show, that the most ancient Ethiopians were a people highly civilized; indeed so much, that the Egyptians were at one time contented to be their scholars. The tone of their language was certainly the same with that of the Chaldeans or Arabian Cushim, from whom they are descended. We know not whether there are any books in the ancient Ethiopic now extant; so that it is not easy to produce instances of its coincidence with the Chaldaic. But Diogenes Laertius[3] informs us, that Thrasyllus, in his catalogue of the books composed by Democritus, mentions one, περι των ἐν Μεροῃ ἱερων γραμματων, concerning the sacred letters in the island of Meroe;[4] and another concerning the sacred letters in Babylon. Had these books survived the ravages of time, they would, in this age of research and curiosity, have determined not only the point under our consideration, but likewise the affinity of sacred rites amongst the Chaldeans, Ethiopians, and Egyptians.

Modern Ethiopic tongues.

We have now shown that the Ethiopians were a colony of Cushites; that the Cushites were originally sovereigns of Shinar or Chaldea, and consequently spoke either Chaldaic, or a dialect of that tongue; that their colonists must have used the same language; and that the ancient Ethiopians were a people highly polished, and celebrated in the most early ages on account of their virtue and piety. It has likewise appeared that the common letters of that people were the sacred characters of the Egyptians. These letters, we imagine, were the Cuphic; for some account of which see the section on the Arabic. When they were discarded, and the modern letters substituted in their room, cannot be determined; nor is it, we apprehend, a matter of much importance. We shall therefore drop that part of the subject, and refer our curious and inquisitive readers to the very learned Job Ludolf's excellent grammar and dictionary of the Abyssinian or Geez tongue,[5] where they will find every thing worth knowing on that subject. We shall endeavour to gratify our readers with a very brief account of the modern Ethiopic or Abyssinian tongue; for which we are principally indebted to that learned, indefatigable, and adventurous traveller, Bruce; who, by his observations on that country, which he made in person, often at the hazard of his life, has discovered, as it were, a new world both to Europe and Asia.

The most ancient language of Ethiopia, which we shall now call by its modern name of Abyssinia, was, according to that gentleman, the *Geez*, which was spoken by the ancient Cushite shepherds. This, we should think, approaches nearest to the old Chaldaic. Upon a revolution in Habesh, the court resided many years in the province of Amhara, where the people spoke a different language, or at least a very different dialect of the same language. During this interval, the Geez, or language of the shepherds, was dropped, and retained only in writing, as a dead language; the sacred Scriptures being in that tongue only saved it from going into disuse. This dialect is exceedingly harsh and unharmonious. It is full of the letters, D and T, on which an accent is put that nearly resembles stammering. Considering the small extent of sea which divides this country from Arabia, we need not wonder that it has great affinity with the Arabic. It is not difficult to be acquired by those who understand any other of the oriental languages; and as the roots of many Hebrew words are only to be found here, it seems to be absolutely necessary to all those who wish to obtain a critical skill in that language.

Ethiopic alphabet.

The Ethiopic alphabet consists of twenty-six letters, each of which, by a *virgula* or point annexed, varies its sound in such a manner as that those twenty-six form as it were sixty-two distinct letters. At first they had only twenty-five of these original letters, the Latin P being wanting; so that they were obliged to substitute another letter in its place. *Paulus*, for example, they call *Taulus*, *Aulus*, or *Caulus*, and *Petros* they pronounced *Ketros*. At last they substituted T, and added this to the end of their alphabet; giving it the force of P, though it was really a repetition of an old character, rather than the invention of a new one. Besides these, there are twenty others of the nature of diphthongs; though some of them are probably not of the same antiquity with the letters of the alphabet, but have been invented by the scribes in later times for the sake of convenience.

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[1] Lib. iii. p. 101, *Steph.*

[2] We find the same observation confirmed by Heliodorus (*Ethiopica*, lib. x. p. 476.) "The royal letters of the Ethiopians," says he, "were the sacred characters of the Egyptians." Cassiodorus likewise assures us, "that the letters inscribed upon the Egyptian obelisks were Chaldean." But recent discoveries have refuted these and other similar statements.

[3] Lib. ix. p. 461. *Causaubon.*

[4] Where the capital of Ethiopia was situated.

[5] A very learned German, who published a grammar and dictionary of the Geez in folio.

The Amharic, during the long banishment of the royal family in Shoa, became the language of the court, and seven new characters were of necessity added to answer the pronunciation of this new language; but no book was ever written in any other language than Geez. There is an old law in the country, handed down by tradition, that whoever shall attempt to translate the Holy Scripture into Amharic, or any other language, his throat shall be cut after the manner in which they kill sheep, his family sold to slavery, and his house razed to the ground.

Before we leave this subject, we may further observe, that all the ancients, both poets and historians, talk of a double race of Ethiopians; one in India, and another in Africa. What can have given rise to this opinion, it is not easy to discover. Perhaps the swarthy complexion of both people may have led them to entertain this opinion. Eusebius indeed informs us,[1] that "a numerous colony of people emigrated from the banks of the Indus, and, crossing the ocean, fixed their residence in the country now called Ethiopia." For our part, we are rather inclined to believe, that the original Ethiopians transported themselves into India, and there perhaps co-operated with the Egyptians in digging the excavations, and framing the statues, some of which are still to be seen in that country, and which we have mentioned in another section of this article. The Greeks called those people Αιθιοπες, *Æthiopes*, we believe from their sun-burned countenances; but indeed they were very little acquainted either with the country or its inhabitants.

Ancient language of Egypt a sister dialect of Hebrew.

The most ancient name of Egypt was *Mizraim*, and consequently the Arabians still call it *Mesri*. It was likewise distinguished by other names, such as *Oceana*, *Aeria*, &c. It appears from the sacred historian, that it was inhabited by the descendants of Mizraim, the second son of Ham. Mizraim had several sons, who, according to the Scriptural account, settled respectively in that country. If we trust to the sacred records, there will be little difficulty in ascertaining the language of the Mizraim. It will appear to have been one of the sister dialects of the Hebrew, Phœnician, Arabic, and Chaldaic. But the origin of the Egyptian people, their language, religion, laws, and institutions, have been so warped and confounded, both by their own historians and by those of other countries, that one is scarcely able to determine what to believe or what to reject. Herodotus, Diodorus Siculus, Strabo, Ptolemy, and most other ancient geographers and historians, are universally agreed, that Egypt, at least that part of it called the *Delta*, was overflown by the sea, and consequently uninhabitable for many centuries after the dispersion of mankind. When we consider the low situation of the Delta, and the violent current of the tide from the coast of Phœnicia and Palestine towards that shore, we would be almost tempted to adopt this hypothesis; but the sacred records avouch the contrary. According to them, Egypt was a populous, rich, and flourishing kingdom, as early as the age of Abraham. But if Lower Egypt had been a stagnant marsh at any time after the general deluge, it could scarcely have been drained, cleared, cultivated, and stocked with inhabitants, as early as the days of Abraham.

Diodorus Siculus, however, is positive that the Egyptians were a colony of Ethiopians;[2] and this he endeavours to prove by the similarity of features, customs, laws, and religious ceremonies, between the two nations. That there was a constant intercourse of good offices between these two branches of the Hamites, cannot be questioned; and that they nearly resembled each other in many respects, is too evident to admit of contradiction. The excavations, originally dug out of the solid rocks of porphyry and marble, in which the natives resided before the plains were drained, have been observed by many judicious travellers,[3] who, having visited that region in modern times, are generally of opinion that the land has gained nothing on the sea since the period when Herodotus wrote his description of that country; and from this circumstance we may conclude, that the idea of the inundation of the Delta is not founded in fact.[4]

But even admitting that the Egyptian Delta has acquired nothing from the sea since the age of Herodotus to the present, it certainly does not follow that the region in question was never overflowed; since there are in many parts of the globe, large tracts of land, certainly once covered with sea, which have continued to this day in the very same situation in which they were two thousand years ago. The decision of this point, however, we leave to the judgment of our readers.

We have already hinted our opinion of the nature of the Egyptian language; but because Egypt is generally thought to have been the native land of hieroglyphics, and because many are of opinion that hieroglyphical characters were prior to alphabetical, we shall hazard a few conjectures respecting that species of writing.

Egyptian hieroglyphics.

The end of speech, in general, is to enable men to communicate their thoughts and conceptions to one another when present; and the use of writing is to perform the same office when people are at so great a distance that vocal sounds cannot mutually reach them. Hieroglyphics are said to have been invented to supply this defect.[5] The most ancient languages were everywhere full of tropes and figures borrowed from sensible objects. As in that stage of society men have not learned to abstract and generalize, all their ideas are borrowed from such objects as most forcibly strike their senses. This circumstance would naturally suggest to savages the idea of conveying their sentiments to each other, when absent, by delineations of corporeal objects. Thus, if a savage asked a loan of his friend's horse, he might find means to have conveyed to him the figure of that animal; and so of other things. This was the very lowest species of graphic communication, and has been styled picture-writing.

But necessity would soon impel our savage correspondents to fabricate a method more extensively useful, which would likewise be suggested by the constant use of the metaphorical mode of speech. Some savage leader, more sagacious than the vulgar herd, would observe that certain sensible objects were fitted, according to the rules of analogy, to represent certain human passions, and even some abstract ideas; and this notion would readily enough be adopted by the many as a new improvement. In this case a *horn* might be the emblem of *power*, a *sword* of *bravery*, a *lion* of *fury*, a *fox* of *cunning*, a *serpent* of *malice*, and so on. By and by artificial signs might be contrived to express such ideas as could not readily be denoted by bodily objects; and this might be called symbolical writing. Such was the foundation of the Chinese characters; and hence the prodigious number of characters of which the written language of that people is composed. Farther they could not proceed, notwithstanding their boasted inventive powers; and farther, we believe, no nation ever did proceed, who had once upon a time no other characters but hieroglyphics. The Mexicans had arrived at the very lowest stage of hieroglyphical writing, but had not taken one step towards alphabetical. The Hurons employed hieroglyphical symbols, but never entertained a single idea of alphabetical. Hieroglyphical characters are the images of objects conveyed to the mind by the organs of vision; alphabetical are arbitrary artificial marks of sound, accommodated by compact to convey to the mind the ideas of objects by the organs of hearing. In a word, we think that there is not the least analogy between these two species to conduct us from the one to the other; and we are therefore of opinion, that hieroglyphical characters were never the vulgar channels of conveyance amongst civilized people.

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[1] *Chron.* p. 12.

[2] Lib. xiii. *passim.*

[3] See Bruce's Travels. vol. i.

[4] Mr. Bruce, Dr. Shaw, Bishop Pococke, Savary, Volney, &c.

[5] It is necessary here to remind our readers, that this article was originally written long before any insight had been obtained into the real nature of the Egyptian methods of writing, by means of the discoveries of Young, Champollion, and others; and that consequently, in as far as relates to the subject of hieroglyphics, many of the author's opinions and conclusions would, in the actual state of our knowledge, require important modifications. But having been induced to reprint it, in consequence of the great learning, research, and ingenuity it displays, we have not conceived it necessary to expunge this defective portion of it; deeming it sufficient to refer the reader for the most recent information to the article Hieroglyphics, and believing that it would even be interesting to compare the opinions entertained by the most learned men of the last generation, with the results which have been obtained from more auspicious and fortunate investigations, in our own day.

We know that in this point we differ from many learned, judicious, and ingenious writers, some of whom have taken much pains to investigate the intermediate stages through which the fabricators of characters must have passed in their progress from hieroglyphical to alphabetical writing. These authors have adopted a plan analogous to Bishop Wilkins' project of an artificial language. In this theory, we own, we were led to suspect that they supposed all mankind were once upon a time savages, and were left to hammer out words, as well as characters, by necessity, ingenuity, experience, or accident. For our part, we have endeavoured to prove, in the section on the Hebrew language, that alphabetical writing was an antediluvian invention; and we have now to state it as our opinion, that amongst all those nations which settled near the centre of civilization, hieroglyphics were comparatively a modern fabrication.

The Orientals are, at this day, extravagantly devoted to allegory and fiction. Plain unadorned truth has to them no charms. Hence that extravagant medley of fables and romance with which all antiquity is replete, and by which all ancient history is disfigured and corrupted. Every doctrine of religion, every precept of morality, was tendered to mankind in parables and proverbs. Hence Scripture speaks of understanding a proverb, the words of the wise, and their dark sayings. The eastern sages involved their maxims in this enigmatical dress for several reasons. They wished to fix the attention of their disciples, to assist their memory, to gratify their allegorical taste, to sharpen their wit and exercise their judgment, and sometimes perhaps to display their own acuteness, ingenuity, and invention. It was amongst the ancients an universal opinion, that the most sacred arcana of religion, morality, and the sublime sciences, were not to be communicated to the uninitiated rabble. For this reason every thing sacred was involved in allegorical mystery.

Here, then, we ought to look for the origin of hieroglyphical or picture-writing amongst the civilized nations of the East. They did not employ that species of writing because they were ignorant of alphabetical characters, but because they thought fit to conceal the most important heads of their doctrines under hieroglyphical figures. The Egyptian priests were most celebrated for their skill in devising those emblematical representations; but other nations likewise employed them. We learn from the fragments of Berosus the Chaldean historian, preserved by Syncellus and Alexander Polyhistor, that the walls of the temple of Belus at Babylon were covered all over with such emblematical paintings. These characters were called ἱεροι, because they were chiefly employed to represent sacred objects; and γλυφικα, because they were originally carved or engraved. Their name points to their original use.[1]

From the above deduction we would conclude, that this species of writing was an adventitious mode in Egypt, peculiar to the priests, and employed chiefly to exhibit things sacred; and that amongst all civilized people it did not supersede the use of alphabetical characters, nor did the use of the latter originate from the former. When alphabetical letters were invented, if indeed they were a human invention, they were antecedent to the other in use and in extent. The Egyptian priests alone knew the true import of those sacred symbols; and communicated that knowledge first to their own children from generation to generation, then to the initiated, and last of all to the grandees of the nation, all of whom were indeed initiated. The hieroglyphics of Egypt were not then the symbols of any sacred occult language, but signs invented by the priests, and prophets or wise men, in order to represent their deities, the attributes and perfections of their gods, the mysteries of their religion, and many other circumstances relating to objects of importance, which were deemed either too sacred or too important to be imparted to the vulgar.

The Egyptians ascribed the invention of letters to a person whom they called *Thoth*, *Theuth* or *Thyoth*,[2] the Greeks Ἑρμης, and the Romans *Mercurius*. Plato calls him a god, or a godlike man;[3] Diodorus makes him privy counsellor to Osiris;[4] Sanchoniathon connects him with the Phœnician Kronos or Saturn.[5] To this Mercury the Egyptians ascribe the invention of all the arts and sciences. He was probably some very eminent inventive genius, who flourished during the first ages of the Egyptian monarchy, and who perhaps taught the rude savages the art of writing.

Two kinds of alphabetical characters in Egypt.

According to Diodorus Siculus, the Egyptians had two kinds of letters;[6] the one sacred, the other common. The former the priests taught their own children, the latter all learned promiscuously. In the sacred characters the rites and ceremonies of their religion were couched; the other sort of writing was accommodated to the ordinary business of life. Clemens Alexandrinus mentions three different styles of writing employed by the Egyptians.[7] "The pupils, who were instructed by the Egyptians, first learned the order and arrangement of the Egyptian letters, which is called *epistolographic*, that is, the manner of writing letters; next, the hieratic character, which the sacred scribes employed; lastly, the hieroglyphic character, one part of which is expressed by the first elements, and is called *cyriologic* or *capital*, and the other *symbolic*. Of the symbolic kind, one part explains properly by imitation; and the other is written tropically, that is, in tropes and figures; and a third by certain enigmatical expressions. Accordingly, when we intend to write the word *sun*, we describe a circle; and when the moon, the figure of the planet appearing horned, conformably to the appearance of that luminary after the change." In this passage we have an excellent description of the three different modes of writing used by the Egyptians; the common, the sacred, and the hieroglyphic. The last Clemens describes according to its three divisions, in exact conformity to our preceding observations.

The sacred letters and language of Egypt Chaldaic.

By the description above translated, it plainly appears, that the sacred characters of the Egyptians were entirely different from the hieroglyphic; and by this consideration we are in a great measure justified, in supposing, as we have all along done, that the sacred letters of the Egyptians were actually the Chaldaic. The inscriptions on the obelisks mentioned by Cassiodorus, so often quoted, were certainly engraved in the sacred characters; but if the sacred characters were Chaldaic, the sacred language was probably the same.

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[1] Instead of pursuing these observations, which the nature of our design will not permit, we must refer our readers to Herodotus, lib. ii. Diodorus Sic. lib. i. Strabo, lib. xvii. Plut. *Isis et Osiris*; and amongst the Christian fathers to Clemens Alexandrinus *Stromata*, and Eusebius *Præparatio Evangelii*, but chiefly to Horus Apollo's *Hieroglyphica*.

[2] Eusebius, *Præp. Evang.* [3] *Phædrus.* [4] Lib. i. [5] *Præp Evang.* Lib. i. [7] *Stromata*, lib. v.

The Egyptians pretended that the Babylonians derived from them the knowledge of the arts and sciences; whilst, on the other hand, the Babylonians maintained, that the Egyptians had been tutored by them. The fact is, they both spoke the same language, used the same religious rites, and had applied with equal success to astrology, astronomy, geometry, arithmetic, and the other sciences; hence there had arisen between the two nations a rivalship, which laid the foundation of these opposite pretensions. The most faithful specimen of the vulgar language of the Egyptians, is, we believe, still preserved in the Coptic, which, however, is so replete with Grecisms, that it must be difficult to trace it out.

Under the Ptolemies, the Greek was the language of the court, and consequently must have diffused itself over a great part of the country. Hence, much of the Coptic consists of Greek words, diversified only by their terminations, declensions, and conjugations. To be convinced of the truth of this, the learned and curious reader need only consult Christian Scholtz's Egyptian and Coptic grammar and dictionary, corrected and published by Godfred Woide, Oxford, 1788.

The Egyptians and Phœnician languages the same.

The Egyptians and Phœnicians were in a manner cousins-german, and consequently must have spoken the same language; that is, one of the sister dialects of the Hebrew, Chaldean, Arabian, Cushite, and others. This is not a mere conjecture; it may be realized by almost numberless examples. It is true, that when Joseph's brethren went down to Egypt, and that ruler deigned to converse with them, they could not understand the Egyptian idiom which he spoke; nor would he, had he been actually an Egyptian, have understood them without an interpreter. The only conclusion from this circumstance is, that by the time in question the Egyptian had deviated considerably from the original language of mankind. The Irish and Welch, every body knows, are only different dialects of the Celtic tongue; and yet experience proves, that a native of Ireland and another of Wales, cannot well comprehend each other's language, nor converse intelligibly without an interpreter. The Gaelic spoken in the Highlands of Scotland, and the Irish, are known to be both branches of the old Celtic; yet a Scotch Highlander and an Irishman can scarcely understand each other's speech. By a parity of reason, a Hebrew and an Egyptian might, in the age of Joseph, speak only different dialects of the same original tongue, and yet find it difficult to understand each other. The fact seems to be, the Hebrew dialect had been in a manner stationary, from the migration of Abraham to that period; whereas the Egyptian, being spoken by a powerful, civilized, and highly cultivated people, must have received many improvements, perhaps additions, in the course of nearly two centuries.

The vulgar letters of Egypt.

The descendants of Canaan and of Mizraim were strictly connected in their religious ceremonies. They worshipped the same objects, namely, the host of Heaven; they mourned for Osiris and Adonis in concert; they carried on a joint commerce, and, as we think, spoke the same language. We may therefore conclude, that their vulgar letters were nearly the same, both in form, in disposition, and in number. Their original number was probably sixteen, viz. five vowels, six mutes, simple and middle, four liquids, and the solitary σ. With these, it is likely, was joined a mark of aspiration, or an *h*, such as we have in the Roman alphabet, and find on some Greek monuments. Cadmus was originally an Egyptian; and that leader brought a new set of letters into Greece. These are generally deemed Phœnician. But they were nearly the same with the ancient Pelasgic, as will be shown in the section on the Greek language. The latter, we think, were from Egypt, and consequently the former must have been from the same region. Danaus, Perseus, Lelex, and others were of Egyptian extraction; and they too adopted the Cadmean characters, without substituting any of their own.

The Jonim or Ionians, emigrated from Gaza, an Egyptian colony; and their letters are known to have differed very little from those of Cadmus and the Pelasgians. The conclusion therefore is, that the vulgar Egyptian letters were the same with the Phœnician.

We are abundantly sensible that there are found upon Egyptian monuments characters altogether different from those which we have here been describing. At what time, by what people, and to what language these letters belonged, we will not pretend to determine. The Ethiopians, the Chaldeans, the Persians, the Greeks, the Romans, and the Saracens, have at different times been sovereigns of that unhappy country; and other nations, whose memory is now buried in oblivion, may have erected monuments, and covered them with inscriptions composed of words taken from different languages, and whimsically devised, with a view to perplex the curious antiquaries of future ages. Some of these are composed of hieroglyphics intermingled with alphabetical characters, artificially disarranged, in order to render them unintelligible; but we do not pretend to develope such texts, because the most inquisitive and sagacious antiquaries are not yet agreed as to their purport and signification.[1]

Egyptian names of Hebrew origin and signification.

We shall now proceed to show, that most part of the names of persons and places which have been conveyed down to us, may, in general, be reduced to a Hebrew, Phœnician, Syrian, or Chaldean original. As the first of these languages is most generally known, we shall therefore employ it as our arch-type or standard, and begin with those terms which occur in Scripture.

The word *Pharaoh*, the title of the *melech* or king of Egypt, is, we think, compounded of two terms, which plainly discover a Hebrew original. According to an oriental tradition, the first who assumed this title was the sovereign of the Hycshos or Royal Shepherds, a race of people from Arabia and Phœnicia. At an early period they conquered Egypt, and kept possession of that country for several centuries. They gloried in the title of ὑκσοι or ὑκουσοι, which according to Josephus, *(contra Apion.)* signifies royal shepherds. The word *Pharaoh*, seems to be compounded of פר *Phar*, a bullock, and רעה, *Rachah*, to feed; hence we think it ought to be written פרעת, *Pharachah*.[2] The name given to Joseph is evidently of kin with the Hebrew; for *zaphnath* differs very little from the Hebrew verb *tzaphan*, which signifies to hide, to keep secret, and *paneah* or *phaneah*, signifies much the same with the Hebrew *phanah*, *aspexit*; so that the name actually intimates one who sees hidden things, which was certainly the very idea the prince intended to be conveyed by giving him that name.[3]

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[1] This, though no longer applicable, was strictly true at the time when the above article was written.

[2] This, we think, is a mistake. The word written *Pharaoh* in Hebrew, was written *Phra* in Egyptian, and is composed of *Ra*, signifying the *sun*, and the ordinary prefix *Ph*, signifying *of* or *from*; so that *Phra*, or, by the insertion of a vowel, *Phara*, means *of the sun*, or *descended of the sun*. Hence the word *Pharaoh* is not a proper name, but a generic term applicable to all the kings of Egypt, from the time of Rhameses to the extinction of the last dynasty of native sovereigns.

[3] For the true explanation of this name, *Zaphnathpaneah*, see the section of the article HIEROGLYPHICS, which treats of the Coptic language.

Potiphar or *Potipherah*, the name of Joseph's father-in-law, has likewise a dialectical affinity with the Hebrew idiom. In that language *patah* signifies to open, to explain, which was one part of the sacerdotal office, and *phar* imports a bullock.[1] Potiphar was then priest of the bullock, that is, the ox, *apis*, sacred to the *sun.*[2] This person was priest or prince of On, which, according to Cyrillus on Hosea, was an Egyptian name of that luminary. The Hebrew word *hon* or *chon*, signifies power, wealth, sufficiency; a very proper epithet for the Sun, who was thought to bestow those blessings. The name of Joseph's wife was *Asenath*, or *Asnath*, compounded of *ishah*, a woman, and *Naith* or *Neith*, an Egyptian name of Minerva, a votary of Minerva.

Almost all the names of cities belonging to Egypt which are mentioned in Scripture are evidently Hebrew. To be satisfied as to this position, the curious reader may consult Jamieson's *Spicilegia*, an excellent book, though very little known. The names of most of the Egyptian deities are significant in the Hebrew tongue; and in that dialect these names appear to have been imposed with great judgment and propriety, all of them plainly indicating some office assigned them, or pointing to some peculiar attribute. We shall produce a few instances.

Osiris was the great divinity of Egypt, and he was certainly the Sun. The Egyptians gave their deities a variety of names in allusion to their various offices and attributes. Jablonski has in a manner wearied himself with tracing the signification of this name. In Hebrew we have *oshir*, to grow rich, to be enriched. The sun may be called the great enricher of nature, and therefore might properly be called by a name alluding to that quality. Isis was both the moon and the earth. *Ishah* is the Hebrew word for *woman*, and Horus Apollo assigns this very derivation. Anubis was one of the names of Mercury amongst the Egyptians, and he was always represented with the head of a dog. He accompanied Isis in her peregrinations in quest of Osiris, and frightened away the wild beasts from attacking the princess. In Hebrew, *nubah* signifies to bark. Here then the analogy is, we think, evident. Many Egyptian names begin with *Can*, such as Canobus, Canopus, &c. The Hebrew word *cahen* or *cohen*, in Syriac *con* or *chon*, intimates both a prince and a priest. *Ob* or *aub*, in Hebrew, imports a bottle, a flaggon, any thing round and prominent like the human belly. In the language of Egypt it was often applied to the sun, in allusion to his rotundity. In the temple of Jupiter Ammon or Amon, in the desert of Libya, there was a statue of the god representing the navel of the human body, which was probably framed in allusion to this fancy. Hence the Pythoness, or people who, according to the Scripture, had familiar spirits, were said to prophecy by the inspiration of Ob, as the Delphic priestess did by that of Apollo. Again, many Egyptian names end with *siris*, as Busiris, Calasiris, Termosiris. This termination is no doubt a cognate of the Hebrew and Chaldean *sar* or *zar*, signifying a prince, or grandee. The river Nile in the Ethiopian dialect is denominated *Siris;* that is, we believe, the king of rivers. The same stream seems to derive the name by which it is generally known, from the Hebrew *nehel*, a valley, or a torrent running down a valley. The same river was often called *oceanus*, a word composed of *og*, *oc*, or *och*, which signifies a king, a leader, and the Hebrew *oin*, a fountain; so that the word imports the king of fountains. The Hebrews always denominated the land of Egypt the land of Mizraim; and the Egyptians themselves, in later times, appear to have called it ’Αιγυπτος, *Ægyptus*, which some think is compounded of *ai*, signifying in Hebrew an island, a country, a province, and *Copt* or *Cupt*, a famous city in that country.[3]

From these specimens, we hope it will appear that the Egyptian language in the more early ages was one of those dialects into which that of the descendants of the postdiluvian patriarchs was divided, and perhaps subdivided, a few centuries after the deluge. Amongst all these, we believe, such an affinity will be found, as plainly demonstrates that they originally sprung from one common stock. Besides, we might easily follow the Egyptian language into Greece, and there trace a great number of Egyptian terms transplanted into Greek; a task, however, which the nature of this inquiry will not permit. If our learned readers should incline to know more of the affinity of the Egyptian tongue with the others so often mentioned, they may consult Bochart's *Chanaan*, Walton's *Prolegomena*, Gebelin's *Monde Primitif*, Jamieson's *Spicilegia*, and other works.

SECT. IV. OF THE PERSIAN LANGUAGE.

The Persian language is divided into the ancient and modern. The former of these is now very imperfectly known; the latter is one of the most expressive, and at the same time one of the most highly polished, in the world. In treating of this language, we shall, in compliance with the plan we have all along followed, begin with the ancient.

At the birth of Mohammed two languages prevailed in Persia.

When Mohammed was born, and Anúshíraván, whom he calls the just king, sat on the throne of Persia, two languages were generally prevalent in that empire.[3] The one called *Deree*, was the dialect of the court, being only a refined and elegant branch of the *Parsee*, so called from the province of which Shiraz is now the capital; and the other, being that of the learned, in which most books were composed, had received the name of *Pahlavi*, either from the heroes who spoke it in former times, or from *pahlu*, a tract of land which included some considerable cities of Iran. The ruder dialects of both were spoken by the rustics of several provinces; and many of these distinct idioms were vernacular, as happens in every kingdom of considerable extent. Besides the Parsee and Pahlavi, a very ancient and abstruse tongue was known to the priests and philosophers, called the language of the *Zend*, because a book on religious and moral duties which they held sacred, and which bore that name, had been written in it; whilst the *Pazend* or commentary on that work was composed in Pahlavi, as a more popular dialect. The letters of this book were called *zend*, and the language *avesta*.

The Zend and the old Pahlavi are now almost extinct in Iran, and very few even of the Guebres can read it; whilst the Parsee remaining almost pure in the *Shah-nameh*, has, by the intermixture of Arabic words, and many imperceptible changes, now become a new language, exquisitely polished by a series of fine writers both in prose and verse, analogous to the different idioms gradually formed in Europe after the subversion of the Roman empire.

Parsee language.

The learned and indefatigable Sir William Jones is confident that the Parsee abounds with Sanscrit words, which have undergone no other change than such as may be observed in the numerous dialects of India; that many Persian imperatives are the roots of Sanscrit verbs; and that even the moods and tenses of the Persian verb substantive, which is the model of all the rest, are deducible from the Sanscrit by an easy and obvious analogy. From all this he infers that the Parsee, like the various idiomatic dialects, is derived from the language of the Brahmins. But the conclusion is, we imagine, not altogether just, since by the same train of reasoning we may infer that the Sanscrit is derived from the Parsee. The same learned gentleman adds, that the multitude of compounds in the Persian language proves that it is not of Arabian but Indian origin. This is undoubtedly true; but though the Parsee is not of Arabian, it does not necessarily follow that it is of Sanscrit origin. It might with the same propriety, and with an equal show of reason, be concluded, that the Greek language is descended of the Sanscrit, because it too abounds with compounds. We may then rest assured, that neither the one nor the other argument adduced by the ingenious president proves that the Parsee is a descendant of the Sanscrit.

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[1] The fact is, *Potiphar*, in Egyptian *Puti-phré*, means *priest of the sun*, from *puti*, priest, and *ra* or *re*, the sun, with the prefix *ph*, signifying *of.*

[2] The Septuagint, (Gen. xli. 45, 50,) translate *On* by ‘Ηλιοπολις.

[3] For the true mythology of ’Αιγυπτος, *Ægyptus*, see the article EGYPT, *sub initio.*

[4] The moderns call the empire of Persia *Iran*, a name unknown to the ancients.

The Pahlahvi.

The same illustrious scholar assures us, that the Zend bears a strong resemblance to the Sanscrit; which, however, it might do without being actually derived from it, since we believe every oriental scholar will find that all the languages from the Mediterranean to the utmost coast of Hindustan exhibit very strong indications of a common origin. The Parsee, however, not being the original dialect of Iran or Persia, we shall not pursue it farther at present, but proceed to give some account of the Pahlavi, which was probably the primitive language of the country. We have observed, above, that the Pazend or commentary on the Zend was composed for the use of the vulgar in the Pahlavi, which, according to Sir William Jones, was a dialect of the Chaldaic; an assertion of which he exhibits the following proof.

From the nature of the Chaldean tongue, most words ended in the first long vowel, like *shemaiá*, heaven; and that very word, unaltered in a single letter, we find in the Pazend, together with *lailiá*, night, *meyá*, water, *nírá*, fire, *matrá*, rain, and a multitude of others, all Arabic or Hebrew, with a Chaldean termination. In like manner, *zamar*, by a beautiful metaphor from pruning trees, means in Hebrew to compose verses, and thence, by an easy transition, to sing them; but in Pahlavi we find the verb *zamarúniten*, to sing, with its forms *zamaraunemi*, I sing, and *zamzunid*, he sang, the verbal terminations of the Persian being added to the Chaldaic root. All these words are integral parts of the language, and not adventitious like the Arabic nouns and verbals engrafted on the modern Persian.

From this reasoning it plainly appears, firstly, that Pahlavi was the ancient language of Persia; and, secondly, that the ancient Persian was a cognate dialect of the Chaldean, Hebrew, Arabic, Phœnician, &c. M. Anquetil has annexed to his translation of the *Zendavesta* two vocabularies in Zend and Pahlavi, which he found in an approved collection of *Rawayat* or traditional pieces in modern Persian. His vocabulary of the Pahlavi strongly confirms this opinion concerning the Chaldaic origin of that language. But with respect to the Zend, it abounded with numbers of pure Sanscrit words, to such a degree, indeed, that six or seven words in ten belonged to that language.

Pahlavi derived from Chaldaic and Sanscrit.

From this deduction it would appear, that the oldest languages of Persia were Chaldaic and Sanscrit, and that when they had ceased to be vernacular, the Pahlavi and Zend were deduced from them respectively, and the Parsee either from the Zend, or immediately from the dialect of the Brahmins; but all had perhaps a mixture of the Tartarian, for the best lexicographers assert, that numberless words in ancient Persian are taken from the Cimmerians. With respect to the last of these, we cannot help being of opinion, that colonies of people from the neighbourhood of Persia had transported themselves into Crim Tartary, and perhaps into Europe, and that these colonists brought along with them those terms which still occur in their dialect. Emigrants from the same region must have found their way into Scandinavia, since numberless Persian words are still current in those regions. Perhaps Odin and his followers emigrated from the neighbourhood of Media and Persia, and brought with them the dialect of the nations from whose country they had taken their departure.

The Zend from the same source.

With respect to the Zend, it might well be considered as a dialect of the Sanscrit; it was probably a sacred language, and if so, concealed from the vulgar, and reserved for the offices of religion. If Zoroastres, or Zaratusht as the Orientals call him, travelled into Egypt, and was initiated in the mysteries of the Egyptian religion, as some pretend that he was, he might have been instructed in the sacred dialect of that people by the priests under whom he studied; and when he returned into Persia, and became the apostle of a new religion, he might have composed the volume of his laws and religious institutions in the sacred language of his Egyptian tutors. This language then became that of the Magi, who concealed it carefully from the knowledge of the uninitiated, as the priests did in Egypt and the Brahmins in Hindustan.

In the section on the Sanscrit language, we shall give a detail of a number of particulars, which to us seem to furnish a presumption that the language in question was imported from Egypt into Hindustan. We confess there are not sufficient data to improve these presumptions into absolute certainty; but we hope the time is not very distant when the members of the Asiatic Society will discover abundant materials to ascertain the truth of this position. We are the rather inclined to adopt this hypothesis, when we consider the character of Zoroastres in connection with that of the Egyptian Cohens and of the Indian Brahmins. . .

If this opinion should one day prove to be well-founded, we believe that the coincidence between the language of the Zend and the Sanscrit will be easily accounted for, without making the Hindus masters of Iran or Persia, and then driving them back to the shores of the Ganges. That the nations of Turan or Scythia did actually overrun that country, and make themselves masters of a considerable part of it at different times, is vouched by the records and traditions of the Persians themselves; and upon those occasions a number of Tartarian words might be introduced into the country, and acquire a currency amongst the inhabitants. But as the annals of ancient Persia have long since been destroyed, it is impossible to ascertain either the extent or duration of these irruptions; indeed the nature of our design does not call for or admit such investigation.

Proofs from Scripture of the origin of the Pahlavi.

In order to corroborate the cognation between the Chaldaic and the Pahlavi languages, we shall subjoin a few arguments derived from the Mosaic history, and the other writings of the Old Testament. These, we believe, will be admitted as irrefragable proofs of the position above advanced, by such as admit the authenticity of the sacred records.

Elam is generally allowed to have been the progenitor of the Persians. This patriarch was the eldest son of Shem who was the son of Noah; and according to the Mosaic account, his posterity settled in the neighbourhood of the descendants of Ashur, Arphaxad, Lud, and Aram, the other sons of Shem. The country where they settled was denominated *Elymais*,[1] as late as the beginning of the Christian era; and this name was retained until the Saracens conquered and took possession of that country. If such was the case, then the Elamites or Persians must have spoken a dialect of the primary language, which, in the first section of this article, we proved to have been the Hebrew.

When the four eastern monarchs invaded the five cities of the plain in Canaan,[2] Chedorlaomer king of Elam was at the head of the confederacy; Amraphel king of Shinar, that is, of Babylon or Chaldea, was one of the allies; Arioch king of Elasar was another; and Tidal, king of some scattered nations in the same neighbourhood, was the fourth. That Chedorlaomer was the principal in this expedition, is obvious from the historian's detail of the second, where that prince is placed first, and the rest are named "the kings that were with him." This passage likewise demonstrates, that Elam, Shinar, and Elasar, lay contiguous, and were engaged in the same cause. Wherever the country in question is mentioned in Scripture prior to the era of Daniel and Ezra, it is always under the name of Elam. To go about to prove this would be superfluous.

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[1] *Strabo*, lib. ii.

[2] Gen. xiv.

According to Xenophon,[1] the Persians knew nothing of horsemanship before the age of Cyrus; but the same historian informs us, that after that monarch had introduced the practice of fighting on horseback, they became so fond of it, that no man of rank would deign to fight on foot. Here it ought to be considered, that this historian was now writing a moral, military, and political romance, and therefore introduced this anecdote, in order to exalt the character of his hero; so that we are not to suppose that the people in question were unacquainted with the art of equitation until that period.

The very name *Phars* or *Pharas* is certainly of Hebrew origin, and alludes to the skill that people professed in horsemanship. The original seems to be *pharsah*, *ungula*, a hoof; and in the Arabic *pharas* intimates a horse, and *pharis* a horseman. Consequently the people were denominated *Parsai*, and the country *Pars*, because they were trained from their infancy to ride the great horse, which indeed they deemed their greatest honour. This name was perhaps at first imposed upon them by the neighbouring nations, and in process of time became their common gentile appellation. Mithras is generally known to have been the chief divinity of the Persians; a name which is plainly derived from *mither*, great. We find in Strabo the Persian god *Amanus*, which is plainly a cognate of *hamah*, the sun or fire. Hence we believe comes *hamarim*, the hearths or chapels, where the fire sacred to the sun was always kept burning, and which the Greeks called Πυραθεια, or fire temples. Herodotus[2] mentions a custom amongst the Persians, according to which, when they came to engage an enemy, they cast a rope with a kind of gin at the end of it on their enemy, and by this means endeavoured to entangle and draw him into their power. The people of Persia who employed this net or gin were called *Sargates*, from *sarags*, *sherag*, or *serig*, a word which in Hebrew, Arabic, and Chaldaic, signifies to hamper or entangle; and hence perhaps the Greek word Σαργανη, a basket or net. *Sar* or *zar* in Hebrew, Phœnician, and Syriac, signifies a lord, a prince; and hence we have the initial syllable of the far-famed *Zartusht* or Zoroaster. In a word, most of the Persian names that occur in the Grecian histories, notwithstanding the scandalous manner in which they have been disguised and metamorphosed by the Greeks, may still with a little skill and industry be traced back to a Hebrew, Chaldaic, Syriac, or Phœnician origin. In the books of Daniel, Ezra, Nehemiah, and Esther, we find a number of Persian names which are all of a Hebrew or a Chaldaic complexion. But to investigate these at much greater length would be foreign to the design of the present article; though, if the curious reader should incline to be more fully satisfied respecting this point, he may consult Bochart's *Chanaan*, D'Herbelot's *Bibliothèque Orientale*, and Walton's *Prolegomena*.

It thus appears, that the Pahlavi is a remnant of the old Persian, and that the latter is a cognate branch of the Hebrew, Chaldaic, Syriac, and Phœnician. We have likewise produced some presumptive proofs that the Zend was copied from the sacred language of the Egyptians; and shall now endeavour to explain by what changes and revolutions the language first mentioned arrived at its present summit of beauty and perfection.

gress of Persian guage.

We have already observed, that the Scythians, whom the old Persians called Σακαι, *Sacæ*, and whom the modern Persians call *Turan*, often invaded and overran Persia at a very early period. The consequence was, an infusion of Scythian or Tartarian terms, with which that language was early impregnated. This in all probability occasioned the first deviation from the original standard. The conquest of Alexander, and the dominion of his successors, must, one would imagine, have introduced an inundation of Greek words. That event, however, seems to have affected the language in no considerable degree, at least very few Grecian terms occur in the modern Persian.

The empire of the *Arsacidæ* or Parthians, we apprehend, produced a very important alteration in the ancient Persian. They were a demi-Scythian tribe; and as they conquered the Persians, retained the dominion of Persia during several centuries, and actually incorporated with the natives, their language must necessarily have given a deep tincture to the original dialect of the Persians. Sir William Jones has observed, that the letters of the inscriptions at *Istakhar* or Persepolis bear some resemblance to the old Runic letters of the Scandinavians. Those inscriptions we conceive to have been Parthian; and, as the Parthians were a Tartarian clan, we think this conjecture may be admitted till another more plausible is discovered. The Persians, it is true, did once more recover the empire, and under them began the reign of the Deree and Parsee tongues; the former consisting of the old Persian and Parthian highly polished; the latter of the same languages in their uncultivated vernacular dress. In this situation the Persian language remained till the invasion of the Saracens in 636, when these barbarians overran and settled in that fine country; demolished every monument of antiquity, records, temples, palaces, and every remain of ancient superstition; massacred or expelled the ministers of the Magian idolatry; and introduced a language, which though not entirely new, yet differed widely from the old exemplar.

But before we proceed to give some brief account of the modern Persian, we must take the liberty of hazarding one conjecture, which perhaps the adepts in the modern Persian may not be very well disposed to admit. In the modern language we find the ancient Persian names wonderfully distorted and deflected from that form under which they appear in Scripture, as well as in Ctesias, Megasthenes, and the Greek authors. From this it has been inferred, that not only the Greeks, but even the sacred historians of the Jews, have changed and metamorphosed them most unmercifully, in order to accommodate them to the standard of their own language. As to the Greeks, we know that this was their constant practice, but we cannot believe as much of the Hebrews, who, we make no doubt, wrote and pronounced the names of the Persian monarchs and governors of that nation nearly in the same manner with the native Persians. It is manifest, beyond all possibility of contradiction, that they altered neither the Tyrian and Phœnician names of persons and places when they had occasion to mention them, nor those of the Egyptians when any such occurred in their writings. The Babylonian and Chaldean names which are mentioned in the Old Testament vary in nothing from the Chaldean original. But no reason can be assigned why they should have transformed the Persian names more than the others. On the contrary, in Ezra, Nehemiah, and Esther, we find the Persian names faithfully preserved throughout.

Nothing now exists in Persic, except the Zend, that is older than the Saracen conquest.

The fact, we imagine, is this. Our modern admirers of the Persian have borrowed their names of the ancient kings and heroes of that country from romances and fabulous legends of more modern date and composition. The archives of Persia were destroyed by the Saracens; and nothing of importance was written in that country till two centuries after the era of Mohammed. What succeeded was all pure fiction and romance. The authors of those entertaining compositions either forged names of heroes to answer their purpose, or laid hold of such as were celebrated in the ballads of their country, or preserved by vulgar tradition. The names were no doubt very different from those of the ancient kings and heroes of Persia; and probably many of them had undergone considerable changes during the continuance of the Parthian empire. Upon this foundation has the learned Mr. Richardson erected a very irregular fabric, which, to use his own expression, seems to be built upon pillars of ice. He has taken much pains to invalidate the credit of the Grecian histories of the Persian empire, by drawing up in battle array against their records legions of romantic writers, who were not born till near a thousand years after the events had taken place; and, to complete the improbability, who lived two hundred years after all the chronicles of the Medes and Persians had been finally destroyed by the fury of the Saracens.

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[1] *Cyropædia*, lib. i.

[2] Lib. ix. cap. 85.

After the decisive victory obtained over the Persians at Kadessa, their ancient government was overturned, their religion proscribed, their laws trampled under foot, and their civil transactions disturbed by the forcible introduction of the lunar for the solar kalendar; whilst, at the same time, their language became almost overwhelmed by an inundation of Arabic words, which, from that period, religion, authority, and fashion, incorporated with their idiom.

The most flourishing period of Persian literature.

From the seventh till the tenth century the Persian tongue, now impregnated with Arabic words, appears to have laboured under much discouragement and neglect. Bagdad, built by Almansor, became, soon after the year 762, the chief residence of the caliphs, and the general resort of the learned and ambitious from every quarter of the empire. At length the accession of the Buyah princes to the Persian throne marked in the tenth century the memorable epoch of the revival of Persian learning. About the year 977 the throne of Persia was filled by the great Azaduddawla, who first assumed the title of Sultan, afterwards generally adopted by eastern princes. He was born in Ispahan, and had a strong attachment to his native kingdom. His court, whether at Bagdad or in the capital of Persia, was the standard of taste and the favourite residence of genius. The native dialect of the prince was particularly distinguished, and soon became the general language of composition in almost every branch of polite learning. From the end of the tenth till the beginning of the fifteenth century may be considered as the most flourishing period of Persian literature. The epic poet Firdousi, in his romantic history of the Persian kings and heroes, displays an imagination and smoothness of numbers hardly inferior to Homer. The whole fanciful range of Persian enchantment he has interwoven in his poems, which abound with the noblest efforts of genius. This bard has stamped a dignity on the monsters and fictions of the East, equal to that which the prince of epic poetry has given to the mythology of ancient Greece. His language may at the same time be considered as the most refined dialect of the ancient Persian, the Arabic being introduced with a very sparing hand; whilst Sadi, Jami, Hafiz, and other succeeding writers, in prose as well as verse, have blended in their works the Arabic without reserve, gaining perhaps in the nervous luxuriance of the one language what may seem to have been lost in the softer delicacy of the other. Hence Ebn Fekreddin Anju, in the preface to the dictionary called *Farhang Jehanguiri*, says, that the Deree and the Arabic idioms were the languages of heaven; God communicating to the angels his milder mandates in the delicate accents of the first, whilst his stern commands were delivered in the rapid accents of the last.

For nearly three hundred years the literary fire of the Persians seems indeed to have been almost extinguished, since, during that time, hardly any thing of that people which deserves attention has appeared in Europe. Enough, however, has already been produced, to inspire us with a very high opinion of the genius of the East. In taste, the orientals are undoubtedly inferior to the best writers of modern Europe; but in invention and sublimity, they are excelled, perhaps equalled, by none. The Persians affect a rhetorical luxuriance, which to a European wears the air of unnecessary redundance. If to these leading distinctions we add a peculiar tone of imagery, of metaphor, and of allusion, derived from the difference of government, manners, temperament, and such natural objects as characterise Asia from Europe, we shall see, at one view, the great points of variation between the writers of the east and the west. Amongst the oriental historians, philosophers, rhetoricians, and poets, many will be found who would do honour to any age or people; whilst their romances, their tales, and their fables, stand upon a ground which Europeans have not yet been able to reach.

The genius of the modern Persic

We shall now annex a few observations on the genius of that noble language; though it is our opinion that the province of the philologist is to investigate the origin, progress, and final improvement of a language, without descending to its grammatical minutiæ or peculiar idiomatic distinctions. We have already observed, that the language under consideration is partly Arabic and partly Persian, though the latter generally has the ascendant. The former is nervous, impetuous, and masculine; the latter is flowing, soft, and luxuriant. Wherever the Arabic letters do not readily incorporate with the Persian, they are either changed into others or thrown away. Their letters are the Arabic with little variation, these being found more commodious and expeditious than the old letters of the Deree and Parsee. Their alphabet consists of thirty-two letters, which, like the Arabic, are read from right to left (their form and order will be learned from any grammar of that language). The letters are divided as usual into vowels and consonants. The Arabic characters, like those of the Europeans, are written in a variety of different hands; but the Persians write their poetical works in the Talick, which answers to the most elegant of our Italic hands.

Resemblance between Persian and English.

There is a great resemblance between the Persian and English languages in the facility and simplicity of their form and construction; the former, as well as the latter, has no difference of terminations to mark the gender either in substantives or adjectives; all inanimate things are neuter; and animals of different sexes have either different names, or are distinguished by the words *ner*, male, and *made*, female. Sometimes indeed a word is made feminine, after the manner of the Arabians, by having an affix annexed to it.

The Persian substantives have but one variation of case, which is formed by adding a syllable to the nominative in both numbers, and answers often to the dative, but generally to the accusative case in other languages. The other cases are expressed for the most part by particles placed before the nominative. The Persians have two numbers, singular and plural, the latter being formed by adding a syllable to the former. The Persian adjectives admit of no variation except in the degrees of comparison. The comparative is formed by adding *ter*, and the superlative by adding *terin* to the positive. The Persians have active and neuter verbs like other nations; but many of their verbs have both an active and neuter sense, which can be determined only by the construction. Those verbs have properly but one conjugation, and but three changes of tense, the imperative, the aorist, and the preterite; all the other tenses being formed by the help of particles or of auxiliary verbs. The passive voice is formed by adding the tenses of the substantive verb to the participle of the active.

In the ancient language of Persia there were few or no irregularities. The imperative, which is often irregular in the modern Persian, was anciently formed from the infinitive, by rejecting the termination *eeden*. Originally all

Persian anguage.

infinitives ended in *den*, till the Arabs introduced their harsh consonants before that syllable, which obliged the Persians, who always affected a sweetness of pronunciation, to change the old termination of some verbs into *ten*, and by degrees the original infinitive grew quite obsolete; yet they still retain the ancient imperative, and the aorists which were formed from it. This little irregularity is the only anomalous part of the Persian language, which, nevertheless, far surpasses in simplicity all other languages ancient or modern.[1]

tility of e Ara- an and ersianlan- uages.

In conclusion, we shall only take the liberty to remind our readers of the vast utility of the Arabian and Persian languages. Numberless events are preserved in the writings of the orientals which were never heard of in Europe, and must have for ever lain concealed from the knowledge of its inhabitants, had not these two tongues been studied and understood by the natives of this quarter of the globe. Many of those events have been transmitted to posterity in poems and legendary tales like the Runic fragments of Scandinavia, the romances of Spain, or the heroic ballads of our own country. Such materials as these, we imagine, may have suggested to Firdausi, the celebrated heroic poet of Persia, many of the adventures of his *Shahnameh;* which, like Homer when stript of the machinery of supernatural beings, is supposed to contain a great deal of true history, and a most undoubted picture of the superstition and manners of the times. The knowledge of these two languages has laid open to Europe all the treasures of oriental learning, and has enriched the minds of Britons with Indian science as much as the produce of the regions has increased their wealth and enervated their constitution.

ersian oetry.

Before we conclude this section, we shall, in order to render our inquiry the more complete, subjoin a few remarks on the nature of Persian poetry. The modern Persians borrowed from the Arabs their poetical measures, which are exceedingly various and complicated, consisting of nineteen different kinds; but the most common of them are the iambic or trochaic measures, and a metre that chiefly consists of those compounded feet which the ancients called *'Επιτριτους*, being composed of iambics and spondees alternately. In lyric poetry their verses generally consist of twelve or sixteen syllables; they sometimes, but seldom, consist of fourteen. Some of their lyric verses contain thirteen syllables; but the most common Persian verse is composed of eleven; and in this measure are written all their great poems, whether upon heroic or moral subjects, as the works of Firdausi and Jami, the Bostar of Sadi, and the Mesnavi of Gelaleddin. This species of verse answers to our common heroic rhyme, which was brought to so high a degree of perfection by Pope. The study of the Persian poetry is so much the more necessary, as there are few books or even letters written in that language, which are not interspersed with fragments of poetry. As to their prosody, nothing can be more easy or simple; and hence when the student can read prose easily, he will with a little attention read poetry with equal facility.

SECT. V. SANSCRIT AND BENGALESE LANGUAGES.

he San- rit one the most cient nguages.

The Sanscrit, although one of the most ancient languages in the world, was little known even in Asia until about the middle of the preceding century. Since that period, by the indefatigable industry of the learned and ingenious Sir William Jones, and the other worthy members of that society of which he had the honour to be president, this noble and ancient language was at length brought to light; and from it vast treasures of oriental knowledge have been communicated both to Europe and Asia; knowledge which, without the exertions of the establishment in question, must have lain concealed from the researches of mankind to the end of the world. In this section we propose to give to our readers such an account of that language as the limits of the present article, and the helps we have been able to procure, shall permit.

Sanscrit and Bengalese Languages.

The Sanscrit language has for many centuries lain concealed in the hands of the Brahmins of Hindustan. It is by them deemed sacred, and is consequently confined solely to the offices of religion. Its name imports the perfect language, or, according to the eastern style, the language of perfection; and we believe no language ever spoken by man is more justly entitled to that high character.

Traces of Sanscrit in every district of Asia and elsewhere.

The grand source of Indian literature, and the parent of almost every dialect from the Persian gulf to the China seas, is the Sanscrit; a language of the most venerable and most remote antiquity, which, though latterly shut up in the libraries of the Brahmins, and appropriated solely to the records of their religion, appears to have been current over most of the oriental world. Accordingly, traces of its original extent may be discovered in almost every district of Asia. Those who are acquainted with that language have often found the similitude of Sanscrit words to those of Persian and Arabic, and even of Latin and Greek; and that not in technical and metaphorical terms, which refined arts and improved manners might have occasionally introduced, but in the main ground-work of language, in monosyllables, the names of numbers, and appellations of such things as would be first discriminated on the immediate dawn of civilization.

The ancient coins of many different and distant kingdoms of Asia are stamped with Sanscrit characters, and mostly contain allusions to the old Sanscrit mythology. Besides, in the names of persons and places, of titles and dignities, which are open to general notice, even to the farthest limits of Asia, may be found manifest traces of the Sanscrit. The scanty remains of Coptic antiquities afford but little scope for comparison between that idiom and this primitive tongue; yet there still exists sufficient ground to conjecture, that, at a very early period, a correspondence did subsist between these two nations. The Hindus pretend, that the Egyptians frequented their country as disciples, not as instructors; that they came to seek that liberal education and those sciences in Hindustan, which none of their own countrymen had sufficient knowledge to impart. The validity of this claim we may perhaps examine hereafter.

Number of books in that language.

But although numberless changes and revolutions have from time to time convulsed Hindustan, that part of it which lies between the Indus and the Ganges still preserves this language whole and inviolate. Here they still offer a thousand books to the perusal of the curious; many of which have been religiously handed down from the earliest periods of human society.

Its characteristics.

The fundamental part of the Sanscrit language is divided into three classes: *Dhaat*, or roots of verbs, which some call primitive elements; *Shubd*, or original nouns; and *Evya*, or particles. The latter are indeclinable, as in all other languages; but the words comprehended in the two former classes must be prepared by certain additions and inflexions to fit them for a place in composition. And here it is that the art of the grammarian has found room to expand itself, and to employ all the powers of refinement. Not a syllable, not a letter, can be added or altered but by regimen; not the most trifling variation of the sense, in the minutest subdivision of declension or conjugation, can be effected without the application of several rules; all the different forms for every change of gender, number, case, person, tense, mood, or degree, are methodically arranged for the assistance of the memory, according to an unerring scale. The number of the radical or elementary parts is about seven hundred; and to these, as to the verbs of other languages, a very plentiful stock of verbal nouns owes its origin; but the latter are not thought to exceed those of the Greek either in quantity or variety.

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[1] With respect to the more minute and intricate parts of this language, as well as its derivations, compositions, and constructions, we must refer our readers to Mininskie's *Institutiones Linguæ Turcicæ, cum rudimentis parallelis Linguarum Arab. et Pers.*; Sir William Jones's Persian Grammar; Mr. Richardson's Arabian and Persian Dictionary; D'Herbelot's *Bibliothèque Orientale;* and Dr. Hyde *de Religione veterum Persarum.* Our readers, who would penetrate into the innermost recesses of the Persian history, colonies, antiquities, connections, dialects, may consult the last mentioned author, especially chap. xxxv, entitled, *De Persia et Persarum nominibus, et de moderna atque veteri lingua Persica, ejusque dialectis.* In the preceding inquiry we have followed other authors, whose accounts appeared to us more natural, and much less embarrassing.

To the triple source of words above mentioned, every term of truly Indian origin may be traced by a laborious and critical analysis. All such terms as are thoroughly proved to bear no relation to any one of the Sanscrit roots, are considered as the production of some remote and foreign idiom, subsequently ingrafted upon the main stock; and it is conjectured, that a judicious investigation of this principle would throw a new light upon the first invention of many arts and sciences, and open a fresh mine of philological discoveries. We shall now proceed to give as exact an account of the constituent parts of this language as the nature of our design will permit.

Sanscrit copious & nervous.

The Sanscrit language is very copious and nervous. The first of these qualities arises in a great measure from the vast number of compound words with which it is almost overstocked. "The Sanscrit," says Sir William Jones, "like the Greek, Persian, and German, delights in compounds; but to a much higher degree, and indeed to such excess, that I could produce words of more than twenty syllables; not formed ludicrously like that by which the buffoon in Aristophanes describes a feast, but with perfect seriousness, on the most solemn occasions, and in the most elegant works." But the style of its best authors is wonderfully concise. In the regularity of its etymology it far exceeds the Greek and Arabic; and, like them, it has a prodigious number of derivatives from each primary root. The grammatical rules are also numerous and difficult, though there are not many anomalies. As one instance of the truth of this assertion, it may be observed, that there are seven declensions of nouns, all used in the singular, the dual, and the plural numbers, and all of them differently formed, according as they terminate with a consonant, with a long or a short vowel; and again, different also as they are of different genders. Not a nominative case can be formed to any one of these nouns without the application of at least four rules, which vary likewise with each particular difference of the nouns, as above stated; and to this it may be added, that every word in the language may be used through all the seven declensions, which is a full proof of the difficulty of the idiom.

The Sanscrit grammars are called *Beeākĕrun*, and of these there are many composed by different authors; some too abstruse even for the comprehension of the Brahmins, and others too prolix to be ever used as references. One of the shortest, named the *Sārăsootee*, contains between two and three hundred pages, and was compiled by Anoŏbhōōtēē Seroopĕnām Achārige, with a conciseness that can scarcely be paralleled in any other language.

Sanscrit alphabet.

The Sanscrit alphabet contains fifty letters; and it is one boast of the Brahmins, that it exceeds all other alphabets in this respect. But it must be observed, that as of their thirty-four consonants, nearly half carry combined sounds, and that six of their vowels are merely the correspondent long ones to as many which are short, the advantage seems to be little more than fanciful. Besides these, they have a number of characters which Mr. Halhed calls connected vowels, but which have not been explained by the learned president of the Asiatic Society.

The Sanscrit character used in Upper Hindustan is said to be the same original letter which was first delivered to the people by Brahma, and is now called *Diewnāgur*, or the language of angels, which shows the high opinion that the Brahmins have entertained of that character. Their consonants and vowels are wonderfully, perhaps whimsically, modified and diversified; but to enumerate them, in this place, would contribute very little either to the entertainment or instruction of our readers. All these distinctions are marked in the *Beids*,[1] and must be modulated accordingly, so that they produce all the effect of a laboured recitative; but by an attention to the music of the chant, the sense of the passage recited equally escapes the reader and the audience. It is remarkable, that the Jews in their synagogues chant the Pentateuch in the same kind of melody; and it is supposed that this usage has descended to them from the remotest ages.

Poetry.

The Sanscrit poetry comprehends a very great variety of different metres, of which the most common are these, viz. 1. The *munnee hurreneh chhund*, or line of twelve or nineteen syllables, which is scanned by three syllables in a foot; and the most approved foot is the anapæst. 2. The *cābee chhund*, or line of eleven syllables. 3. The *anŭshtofe chhund*, or line of eight syllables. Sanscrit poems are generally composed in stanzas of four lines, called *ashlogues*, which are regular or irregular. The most common ashlogue is that of the *anŭshtofe chhund*, or regular stanza of eight syllables in the line. In this measure the greatest part of the *Māhābārat* is composed. The rhyme in this kind of stanza should be alternate; but the poets do not seem to be very nice in the observance of a strict correspondence in the sounds of the terminating syllables, provided the feet of the verse are accurately disposed. This short *anŭshtofe ashlogue* is generally written by two verses in one line, with a pause between; so that the whole assumes the form of a long distich. The irregular stanza is constantly called *anyāchhund*, of whatever kind of irregularity it may happen to consist. It is most commonly compounded of the long line *cābee chhund* and the short *anŭshtofe chhund* alternately; in which form it bears some resemblance to the most common lyric measure of the English poetry.

Origin of this language.

Perhaps our readers may feel some curiosity to be informed as to the origin of this oriental tongue. If we believe the Brahmins themselves, it was coeval with the race of man, as we have already observed towards the beginning of this section. The Brahmins, however, are not the only people who ascribe a kind of eternity to their own particular dialect. We find that the Sanscrit in its primitive destination was appropriated to the offices of religion. It is indeed pretended, that all the other dialects spoken in Hindustan were emanations from that fountain, to which they might be traced back by a skilful etymologist. But this, we think, is an argument of no great consequence, since we believe that all the languages of Europe may, by the same process, be deduced from any one of those current in that quarter of the globe. By a parity of reason, all the different dialects of Hindustan may be referred to the language in question. Indeed, if we admit the authority of the Mosaic history, all languages whatsoever are derived from that of the first man. It is allowed that the language under consideration is impregnated with Persian, Chaldaic, Phœnician, Greek, and even Latin idioms. This, we think, affords a presumption that the Sanscrit was one of those original dialects which were gradually produced amongst the descendants of Noah, in proportion as they gradually receded from the centre of population. What branch or branches of that family emigrated to Hindustan, it is not easy to determine. That they were a party of the descendants of Shem is most nscrit Benga- e Lan- ages

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[1] The books which contain the religion of the Brahmins.

probable, because the other septs of his posterity settled in that neighbourhood. The result then is, that the Hindus were a colony consisting of the descendants of the patriarch Shem.

It appears, however, by almost numberless monuments of antiquity still extant, that at a very early period a different race of men had obtained settlements in that country. It is now generally admitted, that colonies of Egyptians had peopled a considerable part of Hindustan. Numberless traces of their religion occur everywhere in those regions. The learned president himself is indeed positive, that vestiges of these sacerdotal wanderers may be found in India, China, Japan, Tibet, and many parts of Tartary. Those colonists, it is well known, were zealous in propagating their religious ceremonies wherever they resided, and wherever they travelled. There is at the same time even at this day a striking resemblance between the sacred rites of the vulgar Hindus and those of the ancient Egyptians. The prodigious statues of Salsette and Elephanta fabricated in the Egyptian style; the vast excavations hewn out of the rock in the former; the woolly hair of the statues, their distorted attitudes, their grotesque appearances, their triple heads, and various other configurations; all plainly indicate a foreign origin. These phenomena suit no other people upon earth so exactly as the sons of Mizraim. The Egyptian priests used a sacred character, which none knew but themselves; none were allowed to learn except their children and the *élite* of the initiated. All these features mark an exact parallel with the Brahmins of the Hindus. Add to this, that the dress, diet, lustrations, and other rites of both sects, bore an exact resemblance to each other. Sir William Jones has justly observed, that the letters of the Sanscrit, stripped of all adventitious appendages, are really the square Chaldaic characters. We learn from Cassiodorus the following particulars: "The height of the obelisks is equal to that of the circus; now the higher is dedicated to the sun, and the lower to the moon, where the sacred rites of the ancients are intimated by Chaldaic signatures by way of letters."[1] Here then it is plain that the sacred letters of the Egyptians were Chaldaic, and it is allowed that those of the Brahmins were of the same complexion; which affords another presumption in favour of the identity of the Sanscrit with those just mentioned.

That the Egyptians had at a very early period penetrated into Hindustan, is universally admitted. Osiris, their celebrated monarch and deity, according to their mythology, conducted an army into that country, and taught the natives agriculture, laws, religion, and the culture of the vine. He is said to have at the same time left colonies of priests, as a kind of missionaries, to instruct the people in the ceremonies of religion. Sesostris, another Egyptian potentate, likewise overran Hindustan with an army, and taught the natives many useful arts and sciences. When the Shepherd Kings invaded and conquered Egypt, it is probable that numbers of the priests, in order to avoid the fury of the merciless invaders, who demolished the temples and persecuted the ministers of religion, left their native country, and transported themselves into India. These, we should think, were the authors both of the language and religion of the Brahmins. This dialect, as imported by the Egyptians, was probably of the same contexture with the sacred language of that people, as it appeared many ages afterwards. The Indians, who have always been an inventive and industrious race of men, in process of time cultivated, improved, diversified, and constructed that language with such care and assiduity, that it gradually arrived at the high degree of perfection in which it at present appears.

Sanscrit and Bengalese Languages.

Had the learned president of the Asiatic Society, when he instituted a comparison between the deities of Hindustan on the one side, and those of Greece and Italy on the other, examined the analogy between the gods of Hindustan and those of Egypt, we think he would have performed a piece of service still more eminent.[2] Having first demonstrated the similarity between the divinities of India and Egypt, he might then have proceeded to investigate the resemblance of the Egyptian and Phœnician with those of Greece and Rome. By this process a chain would have been formed which would have enabled his readers to comprehend at one view the identity of the Zabian worship wherever it had been established, in the different regions of the earth.

It will be objected to this hypothesis that all the dialects of Hindustan being clearly reducible to the Sanscrit, it is altogether impossible that it could ever have been a foreign language. But to this we answer, that at the early period when this event is supposed to have taken place, the language of the posterity of the sons of Noah had not deviated considerably from the primitive standard, and consequently the language of the Egyptians and the Hindus was nearly the same. The Sanscrit was gradually improved. The language of the vulgar, as is always the case, became more and more different from the original archetype; but it still retained such a near resemblance to the mother-tongue as proved its kindred extraction.

Bengalese language.

To the preceding account of the Sanscrit language we shall annex a few strictures on the language of Bengal; which we believe is derived from the other, and is in most common use in the southern parts of Hindustan.

Though most of the ancient oriental tongues are read from right to left, like the Hebrew, Chaldaic, and Arabic, yet such as properly belong to the whole continent of India proceed from left to right like those of Europe. The Arabic, Persian, and others, are the grand sources whence the former method has been derived; but with these, the numerous original dialects of Hindustan have not the smallest connection or resemblance. The great number of letters, the complex mode of combination, and the difficulty of pronunciation, are considerable impediments to the study of the Bengal language; and the carelessness and ignorance of the people, no less than the inaccuracy of their characters, aggravate these inconveniences. Many of their characters are spurious; and these, by long use and the hurry of business, are now almost naturalized in the language.

The Bengal alphabet, like that of the Sanscrit, from which it is derived, consists of fifty letters, the form, order, and sound of which, may be learned from Mr. Halhed's grammar of the Bengal language. The vowels are divided into long and short, the latter of which are often omitted in writing. Most of the oriental languages are constructed upon the same principle, with respect to the omission of the short vowel. The Hebrews had no sign to express it before the invention of the Masoretic points; in Arabic it is rarely inserted unless upon very solemn occasions, as in the Koran; and in the modern Persian it is universally omitted. To all the consonants in the Sanscrit, however, the short vowel is an invariable appendage, and is never signified by any diacritical mark; but where the construction requires that the vowel should be dropped, a particular stroke is set under the letter. It is in vain to pretend, in a sketch like this, to detail the sound and pronunciation of these letters; this must be acquired by the ear and by practice.

In the Bengal language, there are three genders, as in Greek, Arabic, &c. The authors of this threefold division of genders, with respect to their precedence, appear to have considered the neuter as a kind of residuum resulting from the two others, and as less worthy or less comprehensive than either (see the section on the Greek.) The terminations usually applied upon this occasion are *aa* for the masculine, and *ee* for the feminine. In Sanscrit, as in Greek and Latin, the names of all things inanimate have different genders, founded on vague and incomprehensible distinctions: and this is also the case with the Bengal.

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[1] Lib. iii. epist. ii. et 51.

[2] See that gentleman's discourse, *Asiatic Researches*, vol. i.

Sanscrit and Bengalese nouns.

A Sanscrit noun, on its first formation from the general root, exists equally independent of case as of gender. It is neither nominative, nor genitive, nor accusative; nor is it impressed with any of those modifications which mark the relation and connection between the several members of a sentence. In this state it is called an *imperfect* or *crude* noun. To make a nominative of a word, the termination must be changed and a new form supplied. Thus we see, that, in the Sanscrit at least, the nominative has an equal right with any other inflection to be called a case. Every Sanscrit noun has seven cases, exclusive of the vocative, and therefore comprehends two more than even those of the Latin. Mr. Halhed details all the varieties of these with great accuracy, and to his grammar therefore we must refer our readers. The Bengal has only four cases besides the vocative; and in this respect it is much inferior to the other.

It would be difficult to account for the variety of words which have been allotted to the class of pronouns by European grammarians. The first and second person are chiefly worthy of observation; these two would seem to be confined to rational and conversable beings only. The third supplies the place of every object in nature; where it must necessarily be endued with a capacity of shifting its gender respectively as it shifts the subject; and hence it is in Sanscrit frequently denominated an adjective. One of the demonstratives *hic* or *ille* usually serves for this purpose; and generally the latter, which in Arabic has no other name than *dhemeer el ghaayb*, "the pronoun of the absentee," for whose name it is a substitute.

Bengalese pronouns.

In most languages where the verb has a separate inflection to each person, that inflection is sufficient to ascertain the personality; but in Bengal compositions, though the first and second persons occur very frequently, nothing is more rare than the usage of the pronoun of the third; and names of persons are inserted with a constant and disgusting repetition, to avoid, as it should seem, the application of the words HE and SHE. The second person is always ranked before the first, and the third before the second. The personal pronouns have seven cases, which are varied in a very irregular manner. Leaving these to the Bengalian grammar, we shall proceed to the *verb*.

The Sanscrit, the Arabic, the Greek, and the Latin verbs, are furnished with a set of inflections and terminations so comprehensive and complete, that by their form alone they can express all the different distinctions both of persons and time. Three separate qualities in them are perfectly blended and united. Thus by their root they denote a particular act, and by their inflection both point out the time when it takes place and the number of the agents. In Persian, as in English, the verb admits only of two forms, one for the present tense and one for the aorist; and it is observable, that whilst the past tense is provided for by a peculiar inflection, the future is generally supplied by an additional word conveying only the idea of time, without any other influence on the act implied by the principal verb. It is also frequently necessary that the different state of the action, as perfect or imperfect, be further ascertained in each of the tenses, past, present, and future. This also, in the learned languages, is performed by variations of inflections, for which other verbs and other particles are applied in the modern tongues of Europe and Persia.

Middle voice of Sanscrit verbs.

Every Sanscrit verb has a form equivalent to the middle voice of the Greek, used throughout all the tenses with a reflective sense, and the former is even the most extensive of the two in its use and office. For, in Greek, the reflective can only be adopted intransitively when the action of the verb descends to no extraneous subject; but in Sanscrit, the verb is both reciprocal and transitive at the same time. Neither the Sanscrit, nor the Bengalese, nor the Hindustanee, have any word precisely answering to the sense of the verb *I have*, and consequently the idea is always expressed by *est mihi*; and of course there is no auxiliary form in the Bengal verb corresponding to *I have written*, but the sense is conveyed in another mode. The very substantive, in all languages, is defective and irregular, and therefore the Sanscrit calls it a *semi-verb*. It is curious to observe that the present tense of this verb, both in Greek and Latin, and also in the Persian, appears plainly to be derived from the Sanscrit. In the Bengalese, this verb has but two distinctions of time, the present and the past; the terminations of the several persons of which serve as a model for those of the same tense in all other verbs respectively.

Characteristics Bengale verbs.

Verbs of the Bengal language may be divided into three classes, which are distinguished by their penultimate letter. The simple and most common form has an open consonant immediately preceding the final letter of the infinitive. The second is composed of those words the final letter of which is preceded by another vowel or open consonant going before it. The third consists entirely of causals derived from verbs of the first and second conjugations. The reader will easily conceive the impossibility of prosecuting this subject to any greater length; we shall therefore conclude with a few remarks collected from the grammar so often mentioned, which, we apprehend, may prove more amusing, if not more instructing.

The Greek verbs in μι are formed exactly upon the same principle with the Sanscrit conjugations, even in the minutest particulars. Instances of this are produced in many verbs, which from a root form a new verb by adding the syllable *mi*, and doubling the first consonant. This mode furnishes another presumption of the Egyptian origin of the Sanscrit. Many Greeks travelled into Egypt; many Egyptian colonies settled in Greece; and by one or other of these channels the foregoing innovation might have been introduced into the Greek language. To form the past tense, the Sanscrit applies a syllabic augment, as is done in the Greek; but the future has for its characteristic a letter analogous to that of the same tense in the Greek, and it omits the reduplication of the first consonant. It may be added that the reduplication of the first consonant, is not constantly applied to the present tense of the Sanscrit any more than to that of the Greek verb.

The natural simplicity and elegance of many of the Asiatic languages are greatly debased and corrupted by the continual abuse of auxiliary verbs; and this inconvenience has evidently affected the Persian, the Hindu, and the Bengalese idioms. The infinitives of verbs in the Sanscrit and Bengalese are always used as substantive nouns. Every body knows that the same mode of arrangement very often occurs in the Greek. In the Sanscrit language, as in the Greek, there are forms of infinitives and of participles comprehensive of time; and there are also other branches of the verb which seem to resemble the gerunds and supines of the Latin.

All the terms which serve to qualify, to distinguish, or to augment, either substance or action, are classed by the Sanscrit grammarians under one head; and the word used to express it literally signifies increase or addition. According to their arrangement, a simple sentence consists of three members; and the agent, the action, the subject, which, in a grammatical sense, are reduced to two, the noun and the verb. They have a particular word to specify such words as amplify the noun which imports quality, and answers to our adjectives or epithets. Such as are applied to denote relation or connection, are intimated by another term which may be translated preposition.

Sanscri and Be lese adj tives.

The adjectives in Bengalese have no distinction of gender or number; but in Sanscrit these words preserve the distinction of gender, as in the Greek and Latin. Prepositions are substitutes for cases, which could not have been extended to the number necessary for expressing all the several relations and predicaments in which a noun may be found, without causing too much embarrassment in the form of a declension. They are too few in the Greek language, a circumstance which occasions much inconvenience. The Latin is less polished than the Greek, and consequently bears a much nearer resemblance to the Sanscrit, both in words, inflections, and terminations.

The learned are now convinced that the use of numerical figures was first derived from India. Indeed the antiquity of their application in that country far exceeds the powers of investigation. All the numerals in Sanscrit have different forms for the different genders, as in Arabic. There appears to be a strong probability that the European method of computation was derived from India, as it is much the same with the Sanscrit, although we think the Europeans learned it from the Arabians. The Bengalese merchants compute the largest sums by *fours;* a custom evidently derived from the original mode of computing by the fingers.

The Sanscrit language, amongst other advantages, has a great variety in the mode of arrangement; and the words are so knit and compacted together, that every sentence appears like one complete word. When two or more words come together *in regimine,* the last of them only has the termination of a case; the others are known by their position; and the whole sentence, so connected, forms but one compound word, which is called a *foot.*

SECT. VI. OF THE CHINESE LANGUAGE.

tiquity the Chi- se.

The Chinese, according to the most authentic accounts, are a people of great antiquity. Their situation was such, as, even in the earliest ages of the world, in a great measure secured them from hostile invasion. Their little commerce with the rest of mankind excluded them from the knowledge of those improvements which a mutual emulation had often generated amongst other nations, who were situated in such a manner, with relation to each other, as served to promote a mutual intercourse and correspondence. As China is a large and fertile country, producing all the necessaries, conveniencies, and even luxuries of life, its inhabitants were not under the necessity of looking abroad for the two former, nor exposed to the temptation of engaging in foreign commerce, in order to procure the latter. Perfectly satisfied with the articles which their own country produced, they applied themselves entirely to the practice of agriculture and other arts connected with that profession; and their frugality, which they retain even to this day, taught them the lesson of being contented with little; consequently though their population was almost incredible, the produce of their soil proved abundantly sufficient to yield them a subsistence. Their inventions were their own; and as they borrowed nothing from other people, they gradually began to despise the rest of mankind, and, like the ancient Egyptians, branded them with the epithet of *barbarians.*

This people had at a very early period made amazing proficiency in the mechanical arts. But their progress in the liberal sciences, according to the latest and indeed the most probable accounts, was by no means proportioned. In mathematics, geometry, and astronomy, their knowledge was contemptible; and in ethics, or moral philosophy, the complexion of their laws and customs proves their skill to have been truly superficial. At present they value themselves very highly upon their oratorial talents; and yet of all languages spoken by any civilized people, theirs is confessedly the least improved. To what this untoward defect is owing, the learned have not yet been able to determine.

heir lan- ge an ginal gue.

The language of the Chinese is totally different from the idioms of all other nations, and bears very strong marks of an original tongue. All its words are monosyllabic, and their compositions and derivations are altogether unknown. Their nouns and verbs admit of no flexions; in short, every thing relating to their idiom is peculiar, and incapable of being compared with any other dialect that is spoken by any civilized people. Most barbarous languages exhibit something which resembles an attempt towards those diacritical modifications of speech; whereas the Chinese, after a space of four thousand years, have not advanced one step beyond the very first elements of ideal communication. This circumstance, we think, is a plain demonstration that they did not emigrate from that region where the primitive race of mankind is thought to have fixed its residence. Some have imagined, we believe with good reason, that they are a Tartarian race, which, breaking off from the main body of that numerous and widely-extended people, directed their march towards the south-east, where, falling in with delightful and fertile plains which their posterity now inhabit, they found themselves accommodated so much to their liking, that they dropped all desire of changing their habitations. The country of China is, indeed, so environed with mountains, deserts, and seas, that it would have been difficult for men in the primitive state to have emigrated into any of the neighbouring regions. Thus secluded from the rest of makind, the Chinese were, in all probability, left to the strength of their own inventive powers to fabricate a language, as well as the other arts and improvements necessary for the support and convenience of life.

It is indeed obvious that their vocabulary, when they emigrated from Tartary, was neither ample nor properly accommodated to answer the purposes of the mutual conveyance of ideas. With this slender stock, however, they seem to have been satisfied; for it does not appear that any additions were afterwards made to that which had been originally imported. Instead of framing a new class of terms by compounding the primitive ones; instead of diversifying them by inflections, or multiplying them by derivatives, as is done in every other language; they chose rather to retain their primitive words, and, by a great variety of modifications introduced upon their orthography or pronunciation, to accommodate them to a corresponding variety of significations. Were it possible to scrutinize all the Tartarian dialects, and to reduce them to their primitive monosyllabic character, perhaps the original language of the Chinese might be investigated and ascertained. We know that attempts have been made to compare it with some of the other Asiatic languages, especially the Hebrew; but the task proved unsuccessful, and no primeval identity has been discovered. Before this comparison could be instituted with the most distant prospect of success, the language last mentioned must be stripped of all its adventitious qualities; and not only so, but it must be reduced to the monosyllabic form, and then contrasted with the Chinese monosyllables, an undertaking which we are persuaded would not be readily executed. After all, we are convinced that no resemblance of any importance would be discovered.

Process of its fabrication.

The Chinese language must then, in our opinion, have been a Tartarian dialect, as the people themselves were colonists from Tartary. We have observed above, that this people have not hitherto found out the art of composition of words; a circumstance which is the more surprising, when we consider that, in the characters which form their written language, they employ many compositions. For example, the character by which they represent *misfortune,* is composed of one hieroglyphic which represents a *house,* and another which denotes *fire;* because the greatest misfortune that can befal a man is to have his house burned. With respect to the language which they use in speech, though they very often employ many words to express one thing, yet they never run them together into one word, making certain changes upon them that they may incorporate them more conveniently, but always preserve them entire and unaltered.

Paucity of words.

The whole number of words in the Chinese language does not exceed twelve hundred; and the nouns are only three hundred and twenty-six. It must certainly appear surprising, that a people whose manners are so highly polished and refined, should be able to express so many things as must of necessity be required in such a course of life by so small a number of words, and these too monosyllables. The difficulties which attend this singular mode must be felt at almost every instant; circumstances which, according to the ordinary course of things, should have induced them to attempt both an augmentation of the number of their words, and an extension of those which they had by composition and derivation. We learn from Duhalde that the Chinese have two different dialects: the one vulgar, which is spoken by the common people, and varies according to the different provinces; the other, called the *Mandarin language*, which is current only amongst the learned.[1] The latter is properly that which was formerly spoken at court in the province of *Kiang-nan*, and gradually spread amongst the polite people in the other provinces. Accordingly, this language is spoken with more elegance in the provinces adjoining to *Kiang-nan* than in any other part of the kingdom. By slow degrees it was introduced into all parts of the empire, and consequently became the universal language.

It then appears that the modern language of China was originally the court dialect, and utterly unknown to the bulk of the people. From this circumstance we think it may fairly be concluded that the dialect in question was deemed the royal tongue, and had been fabricated on purpose to distinguish it from the vulgar dialects. We learn from Heliodorus, that the Ethiopians had a royal language which was the same with the sacred idiom of the Egyptians.[2] This Mandarin tongue was originally an artificial dialect fabricated with a view to enhance the majesty of the court, and to raise its very style and diction above that of the rest of mankind. The Chinese, a wonderfully inventive people, might actually contrive a language of that complexion, with an intention to render it obscure and enigmatical.[3] Such a plan would excite their admiration, and would at the same time greatly exceed their comprehension. In process of time, when the Chinese empire was extended, the Mandarins who had been brought up at court, and understood nothing of the provincial dialects, found it convenient to have the most eminent persons in every province taught the language employed by themselves, in order to qualify them for transacting the affairs of government in a language which both parties understood. By this means the royal dialect descended to the vulgar, and in process of time became universal. The Tartar dialect formerly in use vanished; only a few vestiges of it remained, which gradually incorporating with the royal language, occasioned the variation of provincial tongues above mentioned.

We are therefore clearly of opinion, that the modern language of the Chinese was deduced from the original Mandarin, or court dialect, and that this last was an artificial speech fabricated by the skill and ingenuity of that most remarkable people. The learned have long held it as the primary dialect, because, say they, it bears all the marks of an original and unimproved language. In our opinion, nothing appears more ingeniously artificial. It is universally allowed that, in its structure, arrangement, idioms, and phraseology, it resembles no other language. Is not every learned man now convinced that all the Asiatic languages yet known, discover unequivocal symptoms of their cognation and family resemblance? The Ethiopians, Chaldeans, Arabians, Persians, Egyptians, Hebrews, Phœnicians, the Brahmins, Bengalese, the Hindus bordering upon China, all speak only different dialects of one language, varying from the original in dialect only, some in a greater, some in a lesser degree. Why then should the Chinese alone stand altogether insulated and unallied?

The languages of the north all possess congenial features. The Tartar or Tatar dialects of every clan, of every canton, of every denomination, exhibit the most palpable proofs of a near affinity. The Gothic and Sclavonian dialects, which pervade a great part of Europe and some parts of Asia, are obviously brethren, and may easily be traced up to an Asiatic original. Even some of the American jargon dialects contain words which clearly indicate an Asiatic or European original. Our readers, we flatter ourselves, will agree with us, that had the language of the Chinese been the original language, a resemblance must have still existed between it and its descendants. If it had originated from any other language, it would have retained some characteristic features of its parent archetype. But as neither of these is to be found in the fabric of the language under consideration, the conclusion must be, that it is a language entirely different from all other tongues; that it is constructed upon different principles, descended from different parents, and framed by different artists.

The Chinese themselves have a common and immemorial tradition, that their language was framed by *Yao*, their first emperor, to whom they attribute the invention of every thing curious, useful, and ornamental. Traditional history, when it is ancient, uniform, and universal, is generally well founded; and, upon this occasion we think the tradition above mentioned may be fairly admitted as a collateral evidence.

A proof o its artificia structure.

The paucity of vocables contained in this singular language, we consider as another presumption of its artificial contexture. The Chinese *Onomathetæ* would find it an arduous task to devise a great number of new terms, and would therefore rest satisfied with the smallest number possible. In other languages we find the same economy was observed. Rather than fabricate new words, men chose sometimes to adapt old words to new, and, upon some occasions, even to contrary significations. To spare themselves the trouble of coining new terms, they contrived to join several old ones into one; whence arose a numerous race of compounds. Derivatives too were fabricated to answer the same purpose. By this process, instead of creating new vocables, old ones were compounded, diversified, deflected, ramified, metamorphosed, and tortured into a thousand different shapes.[4]

The Greek is deservedly esteemed a very rich and copious language; yet its radical words have been curiously traced by learned men, who, after the most laborious and exact scrutiny, have found that they do not amount to more than three hundred. The Sanscrit language is highly compounded; its radical terms, however, are very few in number. Upon the whole, we think we may conclude, that the more any language abounds in compounds and derivatives, the smaller will be the number of its radical terms. The Arabic admits of no composition, and consequently its words have been multiplied almost *in infinitum;* the Sanscrit, the Persian, and the Greek, abound with compounds, and we find their radicals are few in proportion.

Methods o enriching language.

There are, we think, three different methods which may be employed in order to enrich and extend the range of a language. 1st, By fabricating a multitude of words; the plan which has been pursued by the Arabs. 2d, By framing a multitude of compounds and derivatives; the artifice employed by the Greeks, and the authors of the Sanscrit. 3d, By varying the signification of words without enlarging their number; the method practised by the Chinese and their colonists. The Arabians, we conceive, have shown the most fertile and inventive genius, since they have enriched their language by actually creating a new and a most numerous race of words. The fabricators of the Sanscrit and the collectors of the Greek have exhibited art, but comparatively little fertility of genius. Leaving, therefore, the Arabians, as in justice we ought, masters of the field in the contest relating to the formation of language, we may dispose the Greek and Sanscrit on the one side, and the Chinese on the other; and having made this arrangement, we may attempt to discover on which side the larger proportion of genius and invention seems to rest.

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[1] *History of China*, vol. ii.

[2] *Ethiopica*, lib. vi.

[3] An attempt of this nature, amongst a people like the Chinese, is by no means improbable; nor is its success less probable. For a proof of this, we need only refer to Bishop Wilkins's Artificial Language, and Psalmanazar's Dictionary of the language of Formosa.

[4] See Kennedy on the *Origin and Formation of Languages;* Klaproth, *Asia Polyglotta*, and especially the very learned tract by the same author on the Chinese language; also the works of President de Guignes.

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e.

The Greek and Sanscrit (for we have selected them as being the most highly compounded) exhibit a great deal of art in modifying, arranging, and diversifying their compounds and derivatives, in such a manner as to qualify them for intimating complex ideas; but the Chinese have performed the same office by the help of a race of monosyllabic notes, simple, inflexible, invariable, and at the same time few in number. The question then comes to be, whether more art is displayed in new-modelling old words by means of declensions, compounds, and derivatives; or in devising a plan according to which monosyllabic radical terms, absolutely invariable, should, by a particular modification of sound, be made to answer all the purposes performed by the other. The latter appears to us much more ingeniously artificial. The former resembles a complicated machine composed of a vast number of parts, congenial indeed, but loosely connected; the latter may be compared to a simple, uniform engine, easily managed, and having all its parts properly adjusted. Let us now see in what manner the people in question managed their monosyllabic notes, so as to qualify them for answering all the purposes of speech.

Although the number of words in the Chinese language does not amount to above twelve hundred, yet that small number of vocables, by their artificial management, is sufficient to enable them to express themselves with ease and perspicuity upon every subject. Without multiplying words, the sense is varied almost *in infinitum* by the variety of the accents, inflections, tones, aspirations, and other changes of the voice and enunciation; circumstances which make those who do not thoroughly understand the language frequently mistake one word for another. This will appear obvious by an example. The word *teov* pronounced slowly, drawing out the *v* and raising the voice, signifies a *lord* or *master*. If it be pronounced with an even tone, lengthening the *v*, it signifies a *hog*. When it is pronounced quickly and lightly, it imports a *kitchen*. If it be pronounced in a strong and masculine tone, growing weaker towards the end, it signifies a *column*.

By the same economy, the syllable *po*, according to the various accents, and the different modes of pronounciation, has eleven different significations. It signifies *glass, to boil, to winnow rice, wise or liberal, to prepare, an old woman, to break or cleave, inclined, a very little, to water, a slave or captive*. From these examples, and from almost numberless others which might be adduced, it is abundantly evident that this language, which at first sight appears so poor and confined, in consequence of the small number of the monosyllables of which it is composed, is notwithstanding very copious, rich, and expressive. Again, the same word joined to various others, imports a great many different things; for example, *mou*, when alone, signifies a *tree, wood*, but when joined with another word, it has many other significations. *Mou leoo*, imports wood prepared for building; *mou lan* signifies bars, or wooden grates; *mou hia*, a box; *mou sang*, a chest of drawers; *mou tsiang*, a carpenter; *mou eul*, a mushroom; *mou nu*, a sort of small orange; *mou sing*, the planet Jupiter; *mou mien*, cotton. This word may be joined to several others, and has as many different significations as it has different combinations.

Thus the Chinese, by a different arrangement of their monosyllables, can compose a regular and elegant discourse, and communicate all their ideas with energy and precision; nay even with gracefulness and propriety. In these qualities they are not excelled either by the Europeans or Asiatics, who use alphabetical letters. In fine, the Chinese so naturally distinguish the tones of the same monosyllable, that they comprehend the sense of it, without exercising the least reflection on the various accents by which it is determined.

Effects of this method on pronunciation.

We must not, however, imagine, as some authors have related, that this people cant in speaking, and make a sort of music which is very disagreeable to the ear; the various tones are pronounced so curiously, that strangers find it difficult to perceive their difference even in the province of *Kiang-nan*, where the accent is more perfect than in any other. The nature of it may be conceived by the guttural pronunciation in the Spanish language, and by the different tones which are used in the French and Italian. These tones are almost imperceptible; yet they have different meanings, a circumstance which gave rise to the proverb, that *the tone is everything*.

If the fineness and delicacy of their tones are such as to be scarcely perceptible to a stranger, we must suppose that they do not rise high, but only by small intervals; so that the music of their language must somewhat resemble the music of the birds, which is within a small compass, but nevertheless of great variety of notes. Hence it follows, that strangers will find it very difficult, if not impossible, to learn this language; more especially if they have not a delicate ear and a flexible voice, and also much practice. The great difference then between the Chinese and Greek accents consists in this, that the Greeks had but two accents, the grave and acute, distinguished by a large interval, and that not very exactly marked; for the acute, although it never rises above a fifth higher than the grave, did not always rise so high, and was sometimes pitched lower according to the voice of the speaker. The Chinese must have many more accents, and the intervals between them must be much smaller, and much more carefully marked; for otherwise it would be impossible to distinguish them. At the same time, their language must be much more musical than the Greek, and perhaps more so than any language ought to be; though this has becomes necessary for the purposes above mentioned. Duhalde is positive that notwithstanding the perpetual variation of accents in the Chinese tongue, and the almost imperceptible intervals between these tones, their enunciation does not resemble singing. Many people, however, who have resided in China, are equally positive that the tone in which they utter their words does actually resemble *canting;* and this, when we consider the almost imperceptible intervals by which they are perpetually raising and lowering the pitch of their voice, appears to us highly probable.

As the people of whose language we are treating at present communicate a variety of different significations to their monosyllabic terms by means of varied accentuation, so they employ quantity for the very same purpose. By lengthening or shortening the vowels of their words, they employ them to signify very different things; and they perform the same thing by giving their words different aspirations, as likewise by sounding them with different degrees of roughness and smoothness, and even sometimes by the different motion, posture, or attitude, with which their enunciation is accompanied. By these methods of diversifying their monosyllables, says Duhalde, they make three hundred and thirty of them serve all the purposes of language, and these too not much varied in their termination; since all the words in that language either terminate with a vowel or with the consonant *n*, sometimes with the consonant *g* annexed.

From this account, we think it is evident that the Chinese, by a wonderful exertion of ingenuity, do, by different tones and prosodical modifications, by means of a very inconsiderable number of invariable radicals, actually perform all that the most polished nations have been able to achieve by their compounds, derivatives, &c. diversified by declensions, conjugations, and flexions of every kind; circumstances which, in our opinion, reflect the greatest honour on their inventive powers.

Grammar of the Chinese.

With respect to the grammar of this language, as it admits of no flexions, all their words being indeclinable, their cases and tenses are, therefore, formed by particles. They have no idea of genders; and even the distinction of numbers, which in almost all other languages, however unimproved, is marked by a particular word, is in the Chinese indicated only by a particle. They have no more than the three simple tenses, namely, the past, present, future; and for want of different terminations, the same word stands either for the verb or the verbal substantive, the adjective or the substantive derived from it, according to its position in the sentence. The Chinese language being composed of monosyllables, and these indeclinable, can scarcely be reduced to grammatical rules. We shall, however, attempt to lay before our readers as much of the texture of that singular dialect as may enable them to form some vague idea of its genius and constitution; beginning with the letters, and proceeding regularly to the remaining parts as they naturally succeed each other.

Chinese letters or characters.

The art of joining the Chinese monosyllables together is extremly difficult, and requires a very long and laborious course of study. As they have only figures by which they can express their thoughts, and have no accents in writing to vary the pronunciation, they are obliged to employ as many different figures or characters as there are different tones, which give an equal number of different significations to the same word. Besides some single characters signify two or three words, and sometimes even a whole period. For example, to write these words, *good morrow, Sir*, instead of joining the characters which signify *good* and *morrow* with that of *Sir*, a different character must be used, and this character alone expresses these three words; a circumstance which greatly contributes to multiply the Chinese characters.

This method of joining the monosyllables is indeed sufficient for writing so as to be understood; but it is deemed trifling, and is used only by the vulgar. The style which is employed, in order to shine in composition, is quite different from that which is used in conversation, though the words are in reality the same. In writings of that species, a man of letters must use more elegant phrases, and more lofty expressions, and the whole must be dignified with tropes and figures which are not in general use, but in a peculiar manner adapted to the nature of the subject in question. The characters of Cochin-china, of Tong-king, and of Japan, are the same with those of the Chinese, and signify the same things; though, in speaking, these nations do not express themselves in the same manner. The language of conversation is therefore very different, and they are not able to understand each other; whilst, at the same time, they understand each other's written language, and have all their books in common.

The learned must not only be acquainted with the characters which are employed in the common affairs of life, but must also understand their various combinations, and the numerous and multiform dispositions and arrangements which of several simple strokes make the compound characters. The number of their characters amounts to about eighty thousand; and the man who knows the greatest number of them is of course the most learned. From this circumstance we may conclude, that many years must be employed to acquire the knowledge of such a prodigious number of characters, to distinguish them when they are compounded, and to remember their shape and import. After all, a person who understands ten thousand characters may express himself with tolerable propriety in this language, and may be able to read and understand a great number of books. The generality of their learned men do not understand above fifteen or twenty thousand, and few of their doctors have attained to the knowledge of above forty thousand. This prodigious number of characters is collected in their great vocabulary called *Hai-pien*. They have radical letters, which show the origin of words, and enable them to find out those which are derived from them; for instance, the characters of mountains, trees, man, the earth, a horse, under which must be sought all that belongs to mountains, trees, man, &c. In this search one must learn to distinguish in every word those strokes or figures which are above, beneath, on the sides, or in the body of the radical figure.

Clemens Alexandrinus (see the section on the Chaldaic language) informs us, that the Egyptians employed three sorts of characters: The first was called the *epistolographic* which was used in writing letters; the second was denominated *hieratic*, and peculiar to the sacerdotal order; the last formed the *hieroglyphical*, which was appropriated to monumental inscriptions and other public memorials. This mode of representation was twofold. One, and the most simple, was performed by describing the picture of the object which they intended to represent, or at least one that resembled it pretty nearly; as when they exhibited the sun by a circle and the moon by a crescent. The other was properly symbolic; as when they marked *eternity* by a serpent with the emblem of life, and the *air* by a man clothed in an azure robe studded with stars.

The Chinese, in all probability, had the same variety of characters. In the beginning of their monarchy, they communicated their ideas by drawing on paper the images of the objects they intended to express; that is, they drew the figure of a bird, a mountain, a tree, waving lines, to indicate birds, mountains, forests, rivers, and so on. There were, however, to be communicated an infinite number of ideas, the objects of which do not fall under the cognizance of the senses; such as the soul, the thoughts, the passions, beauty, deformity, virtues, vices, the actions of men and other animals. This inconvenience obliged them to alter their original mode of writing, which was too confined to answer that purpose, to introduce characters of a more simple nature, and to invent others to express those things which are the objects of our senses.

Chinese truly hi glyphica

These modern characters are, however, truly hieroglyphical, since they are composed of simple letters which retain the signification of the primitive characters. The original character for the sun was a circle thus ⊙; and this they called *ga*. They now represent that luminary by the figure |☰|, to which they still give the original name. But human institutions having annexed to these last-framed characters the very same ideas indicated by the original signs, the consequence is, that every Chinese letter is actually significant, and that it still retains its significancy, though connected with others. Accordingly the word *tsai*, which imports misfortune, or calamity, is composed of the letter *mien*, a house, and the letter *ho*, fire; so that the symbolical character for misfortune is the figure of a house on fire. The Chinese characters, then, are not simple letters without any signification, like those of the Europeans and of other Asiatics; but when they are joined together, they are so many ideagraphic signs, which represent or express thoughts.

Upon the whole, the original characters of the Chinese were real pictures; the next improvement was the introduction of the symbolical character; whilst the third and last stage was the present mode, in which artificial signs have been fabricated, to represent such thoughts or ideas as could not be represented by one or other of the methods above described. Duhalde (vol. ii. p. 400, *et seq.*) has furnished us with rules for pronouncing the Chinese vowels and consonants; a piece of information which, as it would be of little consequence to our readers, we shall therefore pass over, and proceed to give a brief account of the Chinese grammar. As the whole language is composed of monosyllables, and these indeclinable, its grammatical structure must be simple and obvious; we shall, therefore, only mention what to us appears singular and important.

C ese pa of sp h.

In the Chinese language there is no diversity of genders or cases, and consequently no declensions. Very often the noun is not distinguished from the verb; and the same word which in one situation is a substantive, may in another become an adjective, and even a verb. The adjective always goes before the substantive; but if it follow it, it becomes a substantive. The cases and numbers are known only by the composition. The plural number is distinguished by the particle *men*, which is common to all nouns; but when the noun is preceded by some word which signifies number, the particle *men* is not annexed. The Chinese genitive, both singular and plural, when it comes after nouns, is often made by *ti*; and there is no other case in that language. The same particle is sometimes placed after pronouns, as if they were derivatives. The comparative degree is formed by adding the particle *keng*, which is always placed before the noun, and signifies *much*. The particle *to* is sometimes used, and likewise imports *much*. The Chinese have only three personal pronouns, *nqo*, I, *ni*, thou, and *ta*, he; and these become plural by adding the syllable *men*. They are made possessive by adding the syllable *ti*, as *nqo ti*, mine, *ni ti*, thine, *ta ti*, his. The patronymics are formed by putting the name of the city, country, or the like, after the pronoun; and *chon* is the relative pronoun *who*, *what*, *which*. Chinese verbs have only three tenses; the preterperfect, the present, and the future. When there is no particle added to the verb, it is the present; the preterperfect is made by adding the particle *leao*; and to distinguish the future tense they use the particle *tsiang* or *hoei*; these being all the varieties incident to their verbs. The Chinese language has no words which are properly adverbs; they only become so by custom, or by the place which they occupy in discourse. They are often obliged to employ several words to express the adverbs of other languages. They have none which are demonstrative, or proper for calling or exhorting; but in their stead they are obliged to use nouns and verbs.

Th nu- me.

Perhaps our readers may wish to know the Chinese numerals, and imagine that they bear a resemblance to those of the European or other Asiatic dialects. In this supposition, however, they will find themselves disappointed. The numerals are as follow:—*y*, one; *eut*, two; *san*, three; *sace*, four; *ou*, five; *lou*, six; *tsi*, seven; *po*, eight; *kieou*, nine; *che*, ten; *che y*, eleven; *eut che*, twelve; *san che*, thirteen; *pe*, one hundred; *eut pe*, two hundred; *y tsien*, one thousand; *y ouan*, one thousand; *che ouan*, twenty thousand; *eut ouan*, one hundred thousand; *che ouan*, two hundred thousand; *ypeouan* one million. There are a great many particles proper to numbers in the Chinese language, which are frequently used, and in a way peculiar to it; for every numeral has a particle importing the object to which it is attached. Thus *co* is used for man, and *y co* for a woman; *hoei* is used for illustrious men; *tche* or *tchi* is used for ships, dogs, hens; *mey* is used for pearls and precious things; *pen* is used for books; *teng* is appropriated to oxen and cows; *too* is used for letters and little bundles of paper; *oo* is employed for corn and pulse. Those distinctions indicate a language manufactured on purpose to be employed by people who were too high and too haughty to converse with the vulgar.

Style of the Chinese writers.

The style of the Chinese, in their elaborate compositions, is mysterious, concise, and allegorical, after the manner of the orientals. It is often obscure to those who do not understand the language thoroughly; and it requires a considerable degree of skill to avoid mistakes in reading an author of elegance and sublimity. Their writers express a great deal in few words; and their expressions are lively, full of spirit, intermingled with bold comparisons and lofty metaphors. They affect to insert in their compositions many sentences borrowed from their five canonical books; and as they compare their books to pictures, so they liken these quotations to the five principal colours employed in painting; and in this their eloquence chiefly consists. They prefer a beautiful character to the most finished picture; and nothing is more common than to see a single page covered with old characters (if they happen to be fair and elegant) sold at a very high price. They honour their characters in the most common books; and when they happen to light by chance upon a printed leaf, they gather it up with the greatest care and respect.

In China there are three varieties of language; that of the common people, that of the people of fashion, and that employed in writing books. Though the first is not so elegant as either of the other two, it is not however inferior to our European languages; notwithstanding those who are but superficially acquainted with the Chinese may imagine it uncouth and barbarous. This low and rude language is pronounced and written many different ways, as is generally the case in other countries. But a more polished, and at the same time a much more energetic, language, is employed in an almost infinite number of novels; some perhaps true, but many more the vehicles of fiction. These are replete with lively descriptions, characters highly finished, morality, variety, wit, and vivacity, in such a degree as to equal in purity and politeness the most celebrated authors of Europe. This was the language of the Mandarins; but though exquisitely beautiful in its kind, it was still inferior to the language of books. This last might be styled the hypersublime; and of it there are several degrees and intervals before an author can arrive at what is called the language of the *king*. This mode of writing cannot be well understood without looking upon the letters; but when understood, it appears easy and flowing. Each thought is generally expressed in four or six characters; nothing occurs that can offend the nicest ear; and the variety of the accents with which it is pronounced produces a soft and harmonious sound.

The difference between the *king* and their other books consists in the difference of the subjects upon which they are written. Those of the former are always grand and sublime, and of course the style is noble and elevated. Those of the latter approach nearer to the common affairs and events of life, and are of consequenee detailed in the Mandarin tongue. In writing on sublime subjects no punctuation is used. As these compositions are intended for the learned only, the author leaves to the reader to determine where the sense is complete; and those who are well skilled in the language readily find it out.

The copiousness of the Chinese language is in a great measure owing to the multitude of its characters. It is likewise occasioned, in some degree, by the difference of their signification, as also by the artificial method of conjunction, which is performed most commonly by uniting the characters two and two, frequently three and three, and sometimes four and four.

Their books numerous and bulky.

Their books are very numerous and bulky, and of course exceedingly cumbrous. A dictionary of their language was compiled in the eighteenth century. It consisted of ninety-five large volumes; and an appendix was annexed of twenty-five volumes. Their other books are voluminous in proportion. The Chinese, one may say, are a nation of learned men. Few people of rank neglect the belles lettres: for ignorance in a man of any degree of eminence is deemed an indelible stain on his character.[1]

Obstacles to improvement in science and literature.

The Chinese have ever looked upon themselves as greatly superior to the rest of mankind. In ancient times they entertained such contemptible notions of foreigners, that they scorned to have any further commerce with them than to receive their homage. They were indeed, at a very early period, highly revered by the Indians, Persians, and Tartars; and in consequence of this veneration, they looked upon themselves as the favourites of Heaven. They imagined that they were situated in the middle of the earth, in a kind of paradise, in order to give laws to the rest of mankind. Other men they looked upon with contempt and disdain, deeming them deformed in body and defective in mind, cast out into the remote corners of the world as the dross and refuse of nature. They boasted that they themselves alone had received from God rational souls and beautiful bodies, in order to qualify them for being sovereigns of the species.

Such are the sentiments of the Chinese; and with such sentiments it is by no means surprising that their improvements in language, in writing, and other appendages of the belles lettres, have not been proportioned to their progress in mechanics. When people are once fully persuaded that they have already arrived at the summit of perfection, it is natural for them to sit down contented, and to solace themselves with the idea of their own superior attainments. The Chinese had early entertained an exalted opinion of their own superiority to the rest of mankind; and therefore imagined that they had already carried their inventions to the *ne plus ultra* of perfection. The consequence was, that they could make no exertions to carry them higher.

The Chinese, for the space of three thousand years, had almost no intercourse with the rest of mankind. This was the consequence of their insulated situation. They of course compared themselves with themselves; and finding that they excelled all their barbarian neighbours, they readily entertained an opinion that they excelled all the rest of mankind in an equal proportion. This conceit at once stifled the emotions of ambition, and deprived them of all opportunities of learning what was going forward in other parts of the world. They despised every other nation. People are little disposed to imitate those whom they despise; and this perhaps may be one reason why they are at this day so averse to adopt the inventions of Europeans.

A superstitious attachment to the customs of the ancients is the general character of the Asiatic nations. This is evidently a kind of diacritical feature amongst the Chinese. The institutions of *Fohi* are looked up to amongst them with the same veneration as those of *Thoth* were amongst the Egyptians. Amongst the latter, there was a law which made it capital to introduce any innovation into the arts of music, painting, or statuary, as instituted by that legislator. We hear of no such law amongst the former; but custom established, and that invariably, for a space of three thousand years, might operate as forcibly amongst them as a positive law did amongst the people first mentioned. An attachment to ancient customs is often more powerful and more coercive than any law which can be promulgated and enforced by mere human authority. These circumstances, we think, may be assigned as the impediments to the progress of the Chinese in the belles lettres, and perhaps in the cultivation of the sciences.

Chinese words found in other languages.

Though the language of the Chinese is confessedly different from all other known languages in its character and construction, it nevertheless contains a great number of words evidently of the same origin with those which occur in other dialects, used by people, who, according to the natural course of things, could never have been connected with that remote country. As an appropriate conclusion to this section, we shall produce here a few of these coincidencies.

1. *China*, or, as the orientals write it, *Sin*, is perhaps the Latin *sinus*, the bosom, the heart, the middle. The Chinese actually imagine that their country is situated in the very middle of the earth, and consequently call it *Cham*, the middle, the heart, a denomination which exactly suits their opinion. 2. *Tu*, in Chinese, intimates every thing that falls under the cognizance of the senses, every thing that strikes the sight; in Latin, *tueor*. 3. *Ta*, a table, a a plank, a figure that renders every thing sensible; *secondly*, to see, to look upon, to appear; Greek ταν τανα, whence τεινω, *tendo*. 4. *Tue*, to examine attentively, to inspect carefully. 5. *Tui*, the most apparent, chief, principal, first; *secondly*, lightning, thunder. 6. *Teu*, a sign by which we know one, letter of acknowledgment. All these ideas are contained in the Hebrew תו, *thu*, *signum*, which we believe has produced the Egyptian *theuth*, the god or godlike man who invented letters, geometry, music, and astronomy. 7. *Tai*, a dye, a theatre; Greek of old, θεαω, then θεαομαι, to see, to look. 8. *Tam*, Latin *tantum*, so much. 9. *Tan*, land, country, region, a syllable annexed to the end of a great number of words, thus, *Aqui tan*, *Aquitania*, a land o. water; *Mauri tan*, *Mauritania*, the land of the Moors. The orientals prefix *s*, and hence *Farsi stan*, *Farsistan*, the land or country of the Persians; *Chusi stan*, *Chusistan*, the country of Chuz; *Turque stan*, *Turquestan*, the land of the Turks. 10. *Ti*, a chief, an emperor, a title of dignity; whence the Greek τιω, to honour, and also the word *di*, bright, glorious; Δις, Jupiter, Διος, divine, the Latin *Dius*, now *Deus*, God, and *Divus*, with the *digamma Æolicum* inserted, the Celtic *Dhia*, &c. It signified originally bright, glorious, and was an epithet of the sun. 11. *Tum*, Latin *tumeo*, to swell. 12. *Liven*, to love; Hebrew לב, *leb*, the heart; Latin *libet*. This word pervades all the dialects of the Gothic tongue, still retaining either the same or a nearly analogous signification. 13. *Li*, letters; Latin, *lino*, to daub, as the Chinese actually do in forming their letters. 14. *Lo*, to contain, that which contains; Celtic, *log;* French, *loge*, *logis*, *loger*. 15. *Lim*, a rule; hence the Latin, *linea*, a line. 16. *Su*, with; Greek, συν, with; Celtic, *cyn*, *cym;* Latin, *cum*, *con*, &c. 17. *Xim*, very high, elevated, sacred, perfect; Latin, *eximius*. 18. *Sin*, the heart; Persian, *Sin*, the heart. 19. *Sien*, chief, first; Celtic, *can*, *céan*, *san*, the head; metaphorically, the chief, the first, the principal; Thibet, *sen*, or *ken*, great, elevated; Arabic, *same*, to be elevated or raised. 20. *Sim*, or *Sing*, a constellation, a star, an element; Hebrew, *shem;* Greek, σημειον, σημα; Latin, *signum*. 21. *Sie*, a man of learning; Goth. Sax. Engl. see, to see, seer. 22. *Cem*, a priest; Hebrew, *cohen;* Syriac, *con;* Egyptian, *can*, *cun*. 23 *Quin*, a king; Celtic, *ken*, *kend*, head, chief; Gothic, *koanig;* Germ. Flem. Engl. *king*, also *queen*. 24. *Hu*, a door; Goth. Germ. Engl. *hus*, *hausen*, *house*. 25. *Min*, a river; Welch, *men*, the water of a river; Latin, *mano*, to flow, and perhaps *amoenus*, pleasant. 26. *Hen*, hatred; Greek, αἰνος, cruel, horrible, odious. 27. *Kiven*, a dog; Greek, κυων, the same. 28. *Ven*, beauty; Latin, *Venus*, *venustas;* Iceland. Swed. *wen*, pleasant; Scotch, *winsome*. 29. *Han*, the soul, breath; Greek, ἀνεμος; Latin, *anima*, *animus*.

To these instances of the analogy between the Chinese language and those of the other people of Asia and Europe many more might be added; but the preceding, it is hoped, will serve as a specimen, which is all that can be expected in an inquiry such as the present.[1]

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[1] For their manner of writing, the implements with which they write, and the materials upon which they draw their characters, we must refer our readers to the article WRITING. It would, we believe, afford our readers considerable pleasure, could we discover and explain the reasons which have hitherto prevented the Chinese from adopting the letters employed from time immemorial by the other nations of Europe and Asia.

SECT. VII. OF THE GREEK LANGUAGE.

rigin of e Greeks

Before we enter upon the consideration of the essential and constituent parts of this noble language, we must beg leave to settle a few preliminaries, which, we trust, will serve to throw some light upon many points that will come under our consideration in the course of the following disquisition.

The Greeks, according to the most authentic accounts, were descended of Javan or Jon, the fourth son of Japhet, the eldest son of the patriarch Noah. The Scriptures of old, and all the orientals to this day, call the Greeks Jonim, or Jaunam, or Javenoth. We have already observed, in the beginning of the article concerning the Hebrew language, that only a few of the descendants of Ham, and the most profligate of the posterity of Shem and Japhet, were concerned in building the tower of Babel. We shall not now resume the arguments then collected in support of that position, but proceed to investigate the character of that branch of the posterity of Javan which inhabited Greece and the neighbouring regions.

At what period the colonists arrived in these parts cannot be certainly determined; nor is it of any great importance in the question before us. That they carried along with them into their new settlements the language of Noah and his family, is, we think, a point which cannot be controverted. We have endeavoured to prove that the Hebrew, or at least one or other of its sister-dialects, was the primeval language of mankind. The Hebrew, then, or one of its cognate branches, was the original dialect of the Jonim or Greeks.

But however this may be, before these people make their appearance in profane history, their language appears to have deviated very widely from this original archetype. By what means, at what period, and in what length of time this change was introduced, is, we believe, a matter not easy to be elucidated. That it was progressive, is abundantly certain from the rules both of analogy and of reason.

hey were g a bar- rous peo-

The colonies, which traversed a large tract of country before they arrived at their destined settlements, must have struggled with numberless difficulties in the course of their peregrinations. The earth, during the period which immediately succeeded the universal deluge, must have been covered with forests, and intersected with swamps, lakes, rivers, and numberless other impediments. As the necessaries, and a few of the conveniencies of life, will always engross the first cares of mankind, the procuring of these comforts will, of necessity, exclude all concern about arts and sciences which are unconnected with such primary pursuits. Hence we think it probable, that most of those colonies that migrated to a very great distance from the plains of Shinar, which are believed to have been the original seat of mankind, in a great measure neglected the practice of the polite but unnecessary modes of civilization, which their ancestors were acquainted with and practised before the era of their migration. Certain it is, that those nations which continued to reside in the neighbourhood of that centre of civilization, always appear in a cultivated state; whilst, at the same time, the colonists who removed to a considerable distance appear to have sunk into barbarism, at a period more early than the annals of profane history can reach. This appears to have been the situation of the primary inhabitants of Greece. Their own historians, the most partial to their own countrymen that can well be imagined, exhibit a very unpromising picture of their earliest progenitors. Diodorus Siculus, in delineating the character of the original men, sketches his outline, we believe, from the first inhabitants of Greece.[2] He represents them as absolute savages, going out in small parties to make war upon the wild beasts of the field, which, according to him, kept them in continual alarm. "Necessity obliged them to band together for their mutual security; they had not sagacity enough to distinguish between the wholesome and poisonous vegetables; nor had they skill enough to lay up and preserve the fruits of autumn for their subsistence during the winter." The scholiast on Pindar describes the situation of the inhabitants of Peloponnesus in the following manner:[3] "Now some have affirmed that the nymphs, who officiated in performing the sacred writes, were called *Melissæ*. Of these Mnaseas of Patara gives the following account. They prevailed upon men to relinquish the abominable practice of eating raw flesh torn from living animals, and persuaded them to use the fruits of trees for food. Melissa, one of them, having discovered bee-hives, ate of the honey-combs, mingled the honey with water for drink, and taught the other nymphs to use the same beverage. She called bees Μελισσαι, *Melissæ*, from her own name, and bestowed much care on the management of them. These things," says he, "happened in Peloponnesus; nor is the temple of Ceres honoured without nymphs, because they first pointed out the mode of living on the fruits of the earth, and put an end to the barbarous practice of feeding on human flesh. The same ladies, too, from a sense of decency, invented garments made of the bark of trees."

Progress of their civilisation.

Hecatæus the Milesian, treating of the Peloponnesians, affirms,[4] "that before the arrival of the Hellenes, a race of barbarians inhabited that region; and that almost all Greece was, in ancient times, inhabited by barbarians.[5] "In the earliest times," says Pausanias, "barbarians inhabited most part of the country called *Hellas*."[6] The original Greeks, if we may believe an author of deep research and superior ingenuity,[7] were strangers to all the most useful inventions of life. Even the use of fire was unknown till it was found out and communicated by Prometheus, who is believed to have been one of the first civilizers of mankind. Hence Æschylus introduces Prometheus commemorating the benefits which he had conferred upon mankind by his inventions,[8] in a strain that indicates the uncultivated state of the world prior to the age in which he flourished.

> "Of the human race
> Now hear the tale, how foolish erst they were:
> I taught them thought and exercise of reason:
> If aught they saw before, they saw in vain.
> Hearing, they heard not; all was shapeless dreams
> For a long space of time, at random mixt
> In wild confusion: for they neither knew
> Tile-cover'd houses standing in the sun,
> Nor timber-work; but, like the earth-bred ant,
> They lodg'd in sunless caves dug under ground:
> No certain sign had they of winter cold,
> Nor of the flow'ry spring, or summer store,
> But blindly managed all; till I them taught
> What time the stars appear, what time they set,
> Hard to be scan'd: then arithmetic rare,
> That queen of arts, by dint of patient thought
> Descry'd, I taught them; and how vocal sounds
> From letters join'd arose."

This character, although applied to mankind in general, was in reality that of the most ancient Greeks. These forbidding features had been transmitted to the poet by tradition as those of his ancestors; but he was a Greek, and consequently imputes them to all mankind without distinction.

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[1] See the article CHINA in this work, particularly the portion of it which treats of the Chinese language.

[2] Lib. i.

[3] *Python.* ode 4.

[4] Strabo, lib. vii.

[5] *Id.* lib. i.

[6] The Greeks borrowed this contemptuous epithet from the Egyptians. See *Herod.* lib. ii. cap. 158.

[7] Plin. *Hist. Nat.*

[8] *Prometh.* verse 441.

Phoroncus, the son and successor of Inachus,[1] is said to have civilized the Argives, and taught them the use of some new inventions. This circumstance raised his character so high among the savage aborigines of the country, that succeeding ages deemed him the first of men.[2] Pelasgus obtained a similar character, because he taught the Arcadians to live upon the fruit of the *fagus*, to build sheds to shelter them from the cold, and to make garments of the skins of swine.

But what most clearly demonstrates the unpolished character of the ancient Greeks, is the extravagant honours lavished by them upon the inventors of useful and ingenious arts. Most of these persons were advanced to divine honours, and became the objects of religious worship to succeeding generations. The family of the Titans affords a most striking instance of this species of adulation. Jupiter, Juno, Mars, Apollo, Venus, Diana, and others, were sprung of this family. By the useful inventions which these persons communicated to the uncultivated nations of Greece, they obtained such lasting and extravagant honours, that they jostled out the sidereal divinities of the country, and possessed their high rank as long as Paganism prevailed in those regions. To these clear testimonies of the savage character of the original Greeks, others almost without number might be added; but those produced in the preceding part of this inquiry will, we trust, satisfy every candid reader as to the truth of the position advanced.

Arrival of a new colony called *Pelasgi.*

Whilst matters were in this situation with respect to the primitive Jonim or Greeks, a new colony arrived in those parts, which in a few years considerably changed the face of affairs. The people who composed this colony were called *Pelasgi;* concerning whose origin, country, character, and adventures, much has been written, and many different opinions have been held by the learned. It is not our province to enter into a detail of their arguments and systems; and we shall content ourselves with informing our readers, that, according to one opinion, they were natives either of Egypt or of Phœnicia, whilst according to another, and that perhaps the most generally received, they were of Thracian, or, in other words, of Gothic origin. See the article PELASGIANS.

In a very able dissertation upon this subject, it has been proved by many plausible arguments, that this people could not be descendants of the Egyptians nor Phœnicians. The author maintains, that the Pelasgians were a great and numerous tribe; that they overspread all the coast of Asia Minor from Mount Mycale to Troas; that they were at one time masters of nearly all the Asiatic and Grecian islands; that they overran Greece and many of the neighbouring countries; and that all this they effected in less than half a century. These facts he appears to have proved from Homer, Herodotus, Diodorus Siculus, Pausanias, and other Greek authors of approved authenticity. He shows, that they were a civilized race of men, and that they were well acquainted with military affairs, legislation, agriculture, navigation, architecture, letters, &c. He insists, that Phœnicia could not at any given period have furnished such a numerous body of emigrants, even supposing that the whole nation had emigrated, leaving their native country a desert. He believes that this event took place before the invasion of Caanan by the Israelites, and that consequently the Pelasgic migration was not occasioned by that catastrophe. He has shown, we think, by very probable arguments, that the Egyptians in the earliest ages were averse to foreign expeditions, especially by sea; that in fact they hated navigation, and, besides, could be under no temptation to emigrate; and that, whilst they had accustomed themselves to live on small matters, their country was exceedingly fertile and easily cultivated. It appears from Herodotus, that the Pelasgians were not acquainted with the religion of the Zabians, which, he conceives, could not have been the case had they emigrated from either of these countries. He makes it appear, that Herodotus is mistaken when he supposes that the deities of Greece were derived from Egypt. He demonstrates, that the names of the greater part of those divinities are of Phœnician extraction; and this opinion he establishes by a very plausible etymological deduction. He asserts, that if the Pelasgians had been natives of either of the countries above mentioned, it would be absurd to suppose them to have been ignorant of the names and the religious rites of their respective nations. He shows, that the Egyptian and Phœnician colonies, which afterwards settled in Greece, were enemies of the Pelasgians, and either subdued or expelled them the country; which, he imagines, would scarcely have been the case had both parties sprung from the same ancestors. And, having settled these points, he concludes, that the people in question were the progeny of the Arabian shepherds, who, at a very early period, invaded and subdued both Lower and Upper Egypt, and after possessing that country for about a century and a half, were conquered by Amenophis king of Upper Egypt, who drove them out of the country; upon which the fugitives retired to Palestine, where Manetho the Egyptian historian loses sight of them, and either through malice or ignorance confounds them with the Israelites. This writer supposes that these fugitives gradually directed their course towards the western and north-western coasts of Asia Minor, whence they passed over to Greece. Such are the arguments by which the author of the dissertation above referred to supports his hypothesis, and, as we think, proves a negative against the opinion that the Pelasgians were natives of Egypt or Phœnicia.[3]

Introduction of letters.

But be this as it may, nothing seems more certain than that the Pelasgians were the first people who in some degree civilized the savages of ancient Greece. It is not our business at present to enumerate the many useful inventions which they communicated to the Greeks, at that time worse than barbarians. We deem it absolutely necessary, however, as an introduction to our subject, to hazard a few conjectures on the language and letters of those adventurers; a point strictly connected with the subject which is about to come under consideration.

Whether we suppose the Pelasgians to have been the offspring of the Phœnicians, Egyptians, or Arabian shepherds, it will make little difference as to their language; because every man of learning and research is convinced that those three nations, especially at the early period in question, spoke a dialect of the Hebrew. The Pelasgians, then, must have spoken a dialect of that language when they arrived in Greece. Perhaps it might have undergone several changes, and acquired some new modifications, during the many years which had passed since they began to be a separate nation, and in the course of numerous peregrinations. Some monuments still extant prove this fact beyond all contradiction. As these people incorporated with the aborigines of Greece, the remains of the original language of mankind, or at least as much of it as had been retained by them, gradually coalesced with that of the new settlers. From this, we think, it is obvious, that prior to the arrival of the new colonists from the East, the language now current amongst the two united tribes must have been a dialect of the Phœnician, Arabian, or Hebrew. But be this as it may, Herodotus[4] affirms that the

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[1] Plato.

[2] Pausanias, lib. viii. c. 1.

[3] If our readers should wish to know more of this subject, they may consult Gebelin's *Preliminary Discourse to his Greek Dictionary*, Lord Monboddo's *Inquiry into the Origin and Progress of Language*, vol. i. towards the end, and Mr. Bryant's *Analysis of Ancient Mythology*, passim.

[4] Lib. i. cap. 59.

Pelasgians in his time spoke a barbarous language, quite unintelligible to the modern Greeks.

The reason of this difference between the language of the Hellenes or Greeks in the age of Herodotus, and that of the remains of the Pelasgians at that period, may easily be conjectured. Previously to the era of that historian, the Greek language had, from time to time, undergone many changes, and received vast improvements; whereas, on the contrary, that of the remnant of the Pelasgians, who were now reduced to a very low state, had remained stationary, and was then just in the same predicament in which it had been a century after their arrival in the country.

Since the Pelasgians, as was above observed, were a people highly civilized and well instructed in the various arts at that time known in the eastern world, they must have been skilled in agriculture, architecture, music, and other arts.[1] The presumption then is that they could not be unacquainted with alphabetical writing. This most useful art was well known in the countries from which they emigrated; and of course it is impossible to imagine that they did not export it as well as the others above mentioned. Diodorus Siculus imagines[2] that the Pelasgians knew not the use of alphabetical letters, but that they received them from Cadmus and his Phœnician followers; and that these letters were afterwards called *Pelasgic*, because the Pelasgians were the first people of Greece who adopted them. But this account must be placed to the score of national vanity, since soon afterwards he acknowledges that Linus wrote the exploits of the first Bacchus and several other romantic fables in Pelasgian characters;[3] and that Orpheus, and Pronapides the master of Homer, employed the same kind of letters. Zenobius likewise informs us that Cadmus slew Linus for teaching characters different from his.[4] These letters could be none other than the Pelasgic.[5]

Pausanias, in his Attics, relates, that he himself saw an inscription upon the tomb of Coræbus, who lived at the time when Crotopus, who was contemporary with Deucalion, reigned as king of the Argives.[6] This inscription then was prior to the arrival of Cadmus; and consequently letters were known in Greece before they were introduced by that chief. It likewise appears from Herodotus himself, that the Ionians were in possession of alphabetical characters before the landing of the Phœnicians. "For," says he, "the Ionians having received letters from the Phœnicians, changing the figure and sound of some of them, ranged them with their own, and in this manner continued to use them afterwards."[7] If, then, the Ionians ranged the Phœnician characters with their own, it is obvious that they had alphabetical characters of their own.[8]

Besides these historical proofs of the existence of Pelasgian characters, monuments bearing inscriptions in the same letters have been discovered in several parts of Greece and Italy, which place this point beyond the reach of controversy. What these characters were may easily be determined. As the Pelasgians emigrated from Arabia, the presumption is that their letters were Phœnician. They are said by Dr. Swinton to have been only thirteen in number, whereas the Phœnician alphabet consists of sixteen. The three additional letters were probably invented by the latter people after the Pelasgians had left the countries of the East. The Phœnician letters imported by the Pelasgians were, no doubt, of a very coarse and clumsy contexture, unfavourable to expedition in writing, and unpleasant to the sight. Besides, the Phœnician characters had not as yet received their names; and accordingly the Romans, who derived their letters from the Arcadian Pelasgians,[8] had no names for theirs. The probability is, that prior to this era the Pelasgian letters had not been distinguished by names. These were of course no other than the original letters of the Phœnicians in their first uncouth and irregular form; and for this reason they easily gave way to the Cadmean, which were more beautiful, more regular, and better adapted for expedition.

The Thracians a powerful nation.

Hitherto we have seen the Pelasgians and the Ionim incorporated, living under the same laws, speaking the same language, and using the same letters. But another nation, and one too of great extent and populousness, had at an early period taken possession of a considerable part of the country afterwards distinguished by the name of *Hellas* or Greece. The Thracians, according to the father of Grecian history, were a great and mighty nation, indeed inferior to none except the Indians.[9] This people, at a very early period, had extended their conquests over all the northern parts of that country. They were, in ancient times, a learned and polished nation. From them, in succeeding ages, the Greeks derived many useful and ornamental sciences. Orpheus the musician, the legislator, the poet, the philosopher, and the divine, is known to have been of Thracian extraction.[10] Thamyris and Linus were his disciples, and were highly respected amongst the Greeks for their learning and ingenuity. That this people spoke the same language with the Greeks, is abundantly evident from the connection between the latter and these old Thracian bards. The Thracian language, then, whatever it was, contributed in a great proportion towards forming that of the Greeks. From the remains of the Thracian dialect there appears to have been a very strong resemblance between it and the Chaldaic. This position we could readily support by the most plausible etymological deductions, did the limits prescribed us in this article admit of such a discussion. It appears, however, that the Thracians, the Getæ, and the Daci or Davi, spoke nearly the same language.[11] The Goths, so much celebrated in the annals of the lower empire, were the descendants of the Getæ and Daci, and consequently must have retained the dialect of their ancestors. The reader, therefore, must not be surprised, if in tracing the materials of which the Greek language is composed, we should sometimes have recourse to the remains of the Gothic.

Greek composed of three dialects.

We have now discovered three branches of the Greek language; that of the Ionim or Aborigines, that of the Pelasgic tribes, and that of the Thracians. These three, we imagine, were only different dialects of the very same original tongue. This assertion might easily be proved by the comparison of a great number of words taken from the two last, were this a proper place for such a discussion.

Cadmus.

Some centuries after the arrival of the Pelasgians, Cadmus, an Egyptian by birth,[12] and a sojourner in Phœnicia, arrived in Bœotia with a multitude of followers; and this chief with his countrymen introduced letters and several other useful improvements into the country in question. As these immigrants were natives of Phœnicia and its environs, their alphabet was that of their native country, consisting of sixteen letters. That the Phœnician alphabet was nearly the same with the Samaritan and Hebrew, has so often and so clearly been demonstrated by the learned that it would be altogether superfluous to insist upon it in the present inquiry. The Phœnicians, as is generally known, wrote from right to left, and the old Grecian characters, inverted, exactly resemble the Phœnician.

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[1] The Arcadians, who were a Pelasgian tribe, were highly celebrated for their skill in music, an art which they introduced into Italy. See *Dion. Halicar.* lib. i.

[2] Lib. iii.

[3] Ibid.

[4] Dr. Gregory Sharp's *Strictures on the Greek Language.*

[5] See Plate CCCCIX.

[6] Lib. i. cap. 49.

[7] Lib. i. c. 58.

[8] The Athenians were originally called *Ionians.*

[8] Livii, lib. i. c. 7.

[9] Herod. lib v. c. 3.

[10] Orpheus seems to be compounded of two oriental words, *or*, light, and *phi*, the mouth; though some deduce it from the Arabian *arif*, a learned man.

[11] Strabo, lib. i. and vii.

[12] Joseph Scaliger's account of the origin of the Ionic letters. Eusebius, *Chronicon.*

Greek Language.

Cadmean letters.

The names of the Cadmean characters are Syrian,[1] which shows the close resemblance between that language and the Phœnician. They stand thus, viz. *alpha, beta, gamla, delta,* &c. The Syrians used to add *a* to the Hebrew words; hence alph becomes alpha, beth, betha or beta, and so on. In the Cadmean alphabet we find the vowel letters, which is an infallible proof that such was the practice of the Phœnicians in the age of Cadmus; and this circumstance also furnishes a presumption that the Jews did the same at the period in question. After all, it is evident that the oldest Greek letters, which are written from right to left, differ very little from those of the Pelasgians. The four double letters θ, φ, ξ, χ, are said to have been added by Palamedes about twenty years before the war of Troy. Simonides is generally supposed to have added the letters ζ, η, ψ, though it appears by ancient inscriptions that these letters were used before the days of Palamedes and Simonides.

The old Ionic character.

In the year 1456 seven brazen tables were discovered at Eugubium, now Gobbio, a city of Umbria in the Apennines, five of which were written in Pelasgian or Etruscan characters, and two in Latin. The first of these tables is believed to have been composed about one hundred and sixty-eight years after the taking of Troy, or twelve hundred and six years before Christ. By comparing the inscription on these tables with the old Ionic characters, the curious have been enabled to discover the resemblance. The old Ionic character written from right to left continued in general use for several centuries. It was composed of the Cadmean and Pelasgian characters, with some variations of form, position, and sound. The Athenians continued to use this character till the year of Rome 350. The old Ionic was gradually improved into the new, and this quickly became the reigning mode. But after the old Ionic was laid aside, the (Βουστροφηδον) Bustrophêdon, came into practice, which goes backwards and forwards as the ox does when ploughing.[2] They carried the line forward from the left, and then backward to the right. The words were all placed close together, and few small letters were used before the fourth century. Such of our readers as wish to know more of letters and alphabets, may consult Chishul, Morton, Postellus, Montfaucon, Gebelin, Astle, and others. For our own part we are chiefly concerned at present with the Phœnician and Cadmean systems; and on these perhaps we may have dwelt too long.

The Greek alphabet derived from the Phœnician.

Having now, we hope, sufficiently proved that the Greek alphabet was derived from the Phœnician, in order to convince our readers of the certainty of our position, as it were by ocular demonstration, we shall annex a scheme of both alphabets, to which we shall at the same time subjoin some strictures upon such letters of the Greek alphabet as admit of any ambiguity in their nature and application.

Α, *alpha*, had two sounds, the one broad like *a* in the English word *all;* the other slender, as *e* in *end, spend, defend.* The Hebrews certainly used it so, because they had no other letter to express that sound; the Arabs actually call the first of their alphabet *elif;* and they as well as the Phœnicians employ that letter to express both the sound of A and E promiscuously. The Greeks call their letter E ε-ψιλον, that is E slender, which seems to have been introduced to supply the place of A slender. Η, *êta*, was originally the mark of the *spiritus asper*, and no doubt answered to the Hebrew ה. It is still retained in that capacity in the word Ηεκατον, and in other with the *spiritus asper* beginning books, chapters, sections, &c. Ε originally marked both the sound of Εψιλον and Ητα; that is, it was sometimes sounded short, as at present, and sometimes long, where it is now supplied by Η. As it was found convenient to distinguish these two different quantities of sound by different letters, they adopted Η, the former *spiritus asper*, to denote the long sound of Ε, and substituted the present *spiritus asper* [ʽ] in its place. Ι, *iota*, is the Hebrew or Phœnician *jod* or *yod.* It appears to have originally served the purpose both of iota and ypsilon. It had two different sounds; the one broad and full, the other weak and slender. The latter had the sound of the modern ὐψιλον. That this was actually the case, appears from several monumental inscriptions; and upon this depends the variation of some cases of the demonstrative pronoun and of the second declension. Ο, *omicron*, or small *o*, in the original Greek had three different sounds. It sounded *o* short, as at present; and likewise *o* long, now denoted by Ω or large O. It likewise marked the sound of the improper diphthong *ου*, sounded like the English diphthong *oo.* The Ω was taken from the Phœnician wau or *V.* Υ, *ypsilon*, we have observed before, was adopted to supply a mark for the sound of I slender. Ζ, *zeta*, is compounded of δ and ς. Dionysius of Halicarnassus, however, informs us, that this letter should be pronounced σδ, according to the Doric plan. Θ, *theta*, was not known in the old Greek. It is compounded of τ and the *spiritus asper*, both which were of old written separately, thus TH. Ξ, *xi*, is compounded of γς, κς, χς. These letters, too, were originally written separately. Φ, *phi.* This letter is compounded of β, π, and the *spiritus asper;* thus, BH, PH. X, *chi*, like the foregoing, is compounded of γ, κ, and the *spiritus asper* as above. Ψ, *psi*, like some of the rest, is made up of βς, πς, which, too, were originally written in separate characters.

These observations are thrown together purely for the use of students who may not choose to inquire into the *minutiæ;* and we regret that the nature of the work does not permit us to extend our researches to greater length. Every language, we believe, was originally composed of inflexible words; and the variations which now distinguish nouns and verbs were the effects of progressive improvements. What might have been the state of the Greek language with respect to these variations in its original form, it is not now possible to discover. That it was rude and irregular, will not, we imagine, be controverted. One of the first attempts towards forming the variations, now denominated declensions and conjugations, would probably be made upon the demonstrative article and the substantive verb. This observation will be found to hold good in most polished languages. In the Greek tongue, it was evidently the method employed.

Origin an flexion of the article

The original Greek article was imported from the East. It was the Hebrew or Phœnician ה *ha.* This particle sometimes signifies *one*, and sometimes it answers to our demonstrative *the;* and both in its adverbial and demonstrative capacity it imports demonstration. In the earliest stages of the two oriental languages, however, it was probably written apart, as *ha-melech*, the king; but in process of time it came to be joined with the following word, as *Hammelech.* From this we think the Greek article was deduced; and it is still retained in the Doric dialect in its pristine character. The difference between *ho* and *ha* in the eastern language is nothing. Here then we have the articles ὁ masculine, and ἁ feminine. Upon these several changes were superinduced, to render them more useful for the purposes of language; but for such changes we know of no archetype.

The Greeks then having adopted the Hebrew, or Phœnician, or Chaldaic article *ha*, and changed it into *ho* for the masculine, seem to have arranged its variations in the following manner:—

	Sing.	*Plu.*
Nom.	ὁ	ὁι
Gen.	ὁυ	ὡν
Dat.	ὁι	ὁις
Acc.	ὁν	ὁυς

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[1] Scaliger

[2] Pausan. lib. viii. cap. 17.

ts use in
he flexion
f nouns.

In the earliest stages of the Greek language, ι and υ were sounded in the same manner, or nearly so, as was observed above. The accusative was at first like the nominative; but for distinction's sake it was made to terminate in ν, which letter was likewise adopted to characterise the genitive plural; and ς was annexed to the dative plural, to distinguish it from the dative singular. The radical word was still without inflexion. When the article was inflected in this manner, the process stood as follows. We take λογος as an example.

	Sing.	*Plu.*
Nom.	ὁ λογ *speech.*	ὁι λογ *speeches.*
Gen.	ὁυ λογ *of speech.*	ὡν λογ *of speeches.*
Dat.	ὁι λογ *to speech.*	ὁις λογ *to speeches.*
Acc.	ὁν λογ *speech.*	ὁυς λογ *speeches.*

In this arrangement our readers will observe, that at the time under consideration, ω was not yet introduced; and therefore ομικρον or little ο was the same letter in the genitive plural as in the accusative singular; but in the latter case it was sounded long by way of distinction.

The article *ha*, which is still retained in the Doric dialect, was varied as follows:—

	Sing.	*Plu.*
Nom.	ἁ	ἁι
Gen.	ἁς	ὡν
Dat.	ἁι	ἁις
Acc.	ἁν	ἁς

These variations differ somewhat from those of the masculine type; and they were no doubt made for the sake of distinction, as is usual in such cases. We shall now give an example of the feminine as it must have stood before variations were introduced, and for this purpose shall employ τιμη.

	Sing.	*Plu.*
Nom.	ἁ τιμ *honour.*	ἁι τιμ *honours.*
Gen.	ἁς τιμ *of honour.*	ὡν τιμ *of honours.*
Dat.	ἁι τιμ *to honour.*	ἁις τιμ *to honours.*
Acc.	ἁν τιμ *honour.*	ἁς τιμ *honours.*

Afterwards, when the Chaldean article *da* was adopted for the neuter gender, the letter ד or *d* was changed into τ, and prefixed to it; and then the Greeks, who, in their declension of adjectives, always followed the neuter gender, began to prefix it to the oblique cases.

In this manner, we think, the Greek nouns stood originally; the only change made being that upon the article. At length, instead of prefixing that word, and expressing it by itself, they found it convenient to affix a fragment of it to the noun, and so to pronounce both with more expedition. Thus, ὁς-λογ e. g. became λογ-ὁς, ὁυ λογ became λογ ὁυ, and of course λογος and λογου, &c. The *spiritus asper*, or rough breathing, was thrown away, in order to facilitate the coalition. Nouns of the neuter gender were distinguished by using ν instead of ς; and in oriental words the Greeks often change ς into ν, and *vice versa*. In this case the Greeks seem to have copied from an eastern archetype. In Hebrew we find an arrangement exactly similar. To supply the place of the pronouns possessive, fragments of the personals were affixed. Thus, the Hebrews wrote *ben-i*, my son, instead of *ben-ani*, and *debir-nu*, our words, instead of *debir-anu*. The persons of their verbs were formed in the same manner. In this way, in our opinion, the variations of the first and second declensions were produced.

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of its
es.

After a very considerable number of their nouns were arranged under these two classes, there remained an almost indefinite number of others which could not conveniently be brought under these arrangements, because their terminations did not readily coalesce with the articles above mentioned. These, like nouns of the neuter gender, were in a manner secluded from the society of the two other classifications; and it is probable that they for a long time continued indeclinable. At last, however, an effort was made to reduce them into a class as well as the others. All these excluded nouns originally terminated with *sigma*, as appears from the genitives as they stand at present. By observing this case, then, we will be readily conducted to the termination of the pristine word or root. The genitive always ends in ος, which termination is formed by inserting ο between the radical word and ς. By throwing out ο we have the ancient nominative. Thus, Τιταν, genitive Τιτανος; leaving out ο we have Τιτανς, the original inflexible termination. Λητω, genitive Λητοος; throw out ο and you have Λητος. Παλλας, genitive Παλλαδος; take away ο and there remains παλλαδς. Ορνις, genitive Ορνιθος; by throwing out ο we have Ορνιθς. Αναξ, genitive Ανακτος, Ανακτς. Κρατος, genitive Κρατεος, Κρατης; originally Κρατος, because primarily ε had the sound of η, as was observed above. Μελι, genitive Μελιτος, Μελιτς. Ειδος, genitive Ειδεος, Ειδες, the old noun. In short, the genitive is always formed by inserting ο immediately before ς, which is always the termination of the nominative; and by this rule, we may easily discover the noun as it existed in its original form.

The dative of this declension was closed with ι *ascriptum*; the same thing occurred in that of the second, namely, ι *subscriptum*. The accusative commonly terminate with α; but was originally ended with ν. The Romans imitated the Æolic dialect, and they commonly ended it with *em* or *im*. The Greeks perhaps in this imitated their progenitors, for α was their favourite vowel. The nominative plural ended in ες, which nearly resembles the English plural, and was probably borrowed from the Thracians. The genitive plural in all the declensions ends in ων; the dative ends in σι, the σ being inserted to distinguish it from the dative singular. When a strong consonant, which would not easily coalesce with ς, comes immediately before it, that consonant is thrown out to avoid a harsh or difficult sound. The result then is; the cases of nouns of the first and second declensions consist of the radical word with fragments of the articles annexed, and these were the first classifications of nouns. The other nouns were left out for some time, and might be denominated *neuters;* but at length they too were classified, and their variations formed as above. In this process the Greeks deviated from the oriental plan; for the people of the East always declined their nouns by particles prefixed. Whether the Greeks were gainers by this new process, we will not pretend positively to determine. We are inclined to imagine, however, that they lost as much in perspicuity as they gained in variety.

Greek ablative.

It is generally believed that the Greeks have no ablative; but to this opinion we cannot assent. It is true, that the dative, and what we would call the *ablative*, are always the same; yet we think there is no more reason to believe that the latter is wanting in Greek, than that the ablative plural is wanting in Latin, because in that language both these cases are always alike.

Genders.

In the eastern languages there are only two genders, analogous to the established order of nature, where all animals are either male or female. But as the people of the East are, to this day, strongly addicted to personification, they ranged all objects of which they had occasion to speak, whether animate or inanimate, under one or other of these two classes. Hence arose what is now called the masculine and feminine genders. The orientals knew nothing whatever of a neuter gender, because all objects were comprehended under the two foregoing classes. The Phœnician feminine was formed from the masculine, by adding אה, *ah*. In this the Greeks in many cases imitated them. The Greeks and Latins left a vast number of substantives, like a kind of outcasts, without reducing them to any gender; and this proceeding gave rise to the neuter gender, which imports, that such substantives were of neither gender; a circumstance which has the appearance of a defect, or rather a blemish, in both. Sometimes, too, they made words neuter, which, according to the analogy of grammar, ought to have been either masculine or femi-

Greek Language.

nine; and again, they ranged words under the masculine or feminine, which by the same rule ought to have been neuter. In short, the doctrine of generical distribution seems to have been very little regarded by the fabricators of both tongues. The beauty which arises from variety seems to have been their only object.

Further observations on the article.

The use of the article in the Greek language is, we think, rather indeterminate, being often prefixed to proper names, where there is no need of demonstration or generical distinction. On the contrary, it is often omitted in cases where both the one and the other seem to require its assistance. In short, in some cases it seems to be a mere expletive. Though both Lord Monboddo and Mr. Harris have treated of this part of speech, neither the one nor the other has ascertained its proper use.[1] We know not any objection to the early use of articles amongst the Greeks so plausible as the total neglect of them amongst the Romans. But it ought to be considered, that after the flexions had been introduced, the use of the article was in a great measure neglected. Accordingly, Lord Monboddo observes that it is very seldom used as such by Homer, but commonly instead of the relative pronoun ὁς, ἡ, ὁ. Thus it would appear, that at the time when the Roman language was reduced to the Grecian standard, the article was not commonly used by the Greeks; and consequently the Latins never employed it. There can be no doubt that the pronoun *who*, in the northern languages, is the same with the Greek ὁ, and the Hebrew *hua*. This amongst the northern nations is always a relative, which affords a presumption that the Greeks originally used the article in the same manner as we do at present. The fact is, that the articles having once got into vogue, were often positively used as mere expletives to fill up a gap; and, on the other hand, when there was no occasion for pointing out an object, fully determined by the tenor of the discourse, it was often omitted.

Adjectives.

In forming adjectives, they followed the same plan that they had done with substantives. Their great effort was to make their adjectives agree with their substantives in gender, in number, and in case. This arrangement improved the harmony of speech; and nothing could be more natural than to make the word expressing the quality correspond with the subject to which it belonged. As adjectives denote qualities, and are thus susceptible of degrees, nature taught them to invent marks for expressing the difference of these degrees. The qualities may exceed or fall below each other by almost numberless proportions; it was, however, found convenient to restrict such increments and decrements to two denominations. The positive is, properly speaking, no degree of comparison at all; therefore we need only point out the formation of the comparative and superlative. The former is generally thought to have been fabricated, by first adding the Hebrew word יהר, *excellent*, to the positive, and then affixing the Greek termination ος; and the latter, by affixing the Syrian word *tath* and the syllable ος, in the same manner.

Greek numerals.

Every nation, even the most uncivilized, must have early acquired the notion of number. Numerical characters and names are the same in many different languages. These terms were discovered, and in use, long before grammar attained to any perfection; and therefore they remain either inflexible or irregular. The first way of computing amongst the Greeks was by the letters of the alphabet; so that Α signified *one*, and Ω *twenty-four*; in this manner the rhapsodies of Homer are numbered; and so are the divisions of some of the Psalms, as is generally known. But a more artificial plan of computation was obviously necessary. They therefore divided the letters of the alphabet into *decades* or tens, from Α to Ι = 10. To express the number 6, they inserted ϛ; so that by this means the first decade amounted to 10. In the next decade every letter increased by tens, and so Ρ denoted 100. In this decade they inserted ϟ κοππα = 90. In the third, every letter rose by 100; so that ϡ) σανπι = 900. By inserting these three Phœnician characters they made their alphabet amount to 900. To express chiliads or thousands, they began with the letters of the alphabet as before; and to make the distinction, they placed a dot under each character, as the units, tens, hundreds, were distinguished by an acute accent over them.

But in monumental inscriptions, and also in public instruments, a larger and more lasting numerical character was fabricated. They began with Ι, and repeated that letter till they arrived at Π = 5. This is the first letter of πεντε, *five*. They then proceeded, by repeating Ι till they came to 10 Δ, the first letter of δεκα, 10. Then they repeated Δ over and over, so that four Δ = 40. To express 50, they inclosed Δ in a sort of open square $|\bar{\Delta}|$ = 50, $|\bar{H}|$ = 500, $|\bar{M}|$ = 50,000, &c. Often, however, Χ signifies 1000, and then we have δις Χιλιοι, 2000; τρις Χιλιοι, 3000; and so of the rest.

Pronouns.

The term pronoun signifies a word employed instead of a noun or name; and indeed the personal pronouns are really such. This needs no explication. The pronoun of the first person is one of those words which have continued invariable in all languages; and the other personals are of the same character. The relatives, possessives, demonstratives, and gentiles, are generally derived from these, as may be discerned by a very moderate adept in the language. Our readers will therefore, we hope, easily dispense with our dwelling upon this part of speech.

Greek verbs.

In most ancient languages, verbs, according to the order of nature, have only three tenses or times, namely, the past, the present, and the future. The intermediate tenses were the invention of more refined ages. The Greek, in the most early periods of their language, had no other tenses than those above mentioned. The manner of forming these we shall endeavour to point out, without touching upon the nature of the rest, since an idea of them may be acquired from any common grammar.

It has already been observed, that the flexion of nouns of the first and second declensions are formed by annexing fragments of the articles to the radical words; and that the variation of the tenses was produced by joining the substantive verb, according to the same analogy. Every Greek verb was originally an inflexible biliteral, triliteral, quadriliteral or dissyllabic radix; and the variations were formed, a long while afterwards, in the manner above intimated.

The Greeks derived their substantive or auxiliary verb, from the Phœnician or Chaldean verb היה, *fuit*, which verb, taking away the gentle aspiration from both beginning and end, actually became ει. This form the Greeks brought along with them from the East, and manufactured after their own manner, which appears to have been thus:

Pres. εω, εες, εε, εομεν, ϝετε, εοσι,
Cont. ω, εις, ει, ουμεν, ειτε, ουσι,
Fut. εσω, εσεις, εσει, εσομεν, &c.

We here place οσι in the third person plural, because for many centuries ὀμικρον supplied the sound of the diphthong ου. By these variations it will appear that the radical verb was rendered capable of inflection. We have observed that Greek verbs were a collection of biliteral, triliteral, or quadriliteral, radical words. The following may serve as examples: τι, λεγ, Μαρ, τυπ, φαν, ταν, ραπ, Δαμ, Δηλ, Δεικ. These radicals are taken at random; and we believe that a student of Greek, by adding the terminations, will readily find them to be all significant verbs. With these radicals, then, and the substantive verb, the present and future tenses were formed.

The second future.

But it is now generally admitted that the modern was not the original present tense of the verb. The second, or Attic future, appears evidently to have been the most ancient present. When the language was improved, or rather in the course of being improved, a new present was invented, derived indeed from the former, but differing widely from it in its appearance and complexion. Upon this occasion, the old present was degraded, and instead of intimating what was *doing at present*, was made to import what was immediately to be done hereafter. By this means, γραφεω, contracted in γραφῶ, *I am writing*, came to intimate, *I am just going to write*. This change was probably made for the sake of enriching the language, and giving variety and energy. Thus, τυπεω contracted τυπῶ became τυπτω, τικῶ, τικτω, &c. According to this theory, we find, that such verbs as have now no second future retain their original form, only the circumflex has been removed in order to accommodate them to the general standard. Grammarians have chosen the three characteristic letters of active verbs from the present, first future, and perfect: but the true characteristic of the original verb was that of the present second future. Many verbs are now destitute of this tense, because since the invention of the new present, the former one has fallen into disuse.

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[1] See *Origin and Progress of Language*, vol. ii. p. 53. *Hermes*, p. 214, *et seq.*

rmation the mo- n pre- t.

Let us now take the verb λενω. *dico*. in order to make a trial; and let us write the radix and tne auxiliary, first separately, and then in conjunction. Thus, λεγ-εω, λεγ-εες, λεγ-εε, λεγ-εομεν, λεγ-εετε, λεγ-εοσι. Then we shall have contracted λεγῶ, λεγεῖς, λεγεῖ, λεγοῦμεν, λεγεῖτε, λεγουσι. Here, we believe, every thing is self-evident. The English of this would be, "Saying, *I am*, saying *thou art*, saying *he is*," &c. At first the radix and the auxiliary were pronounced separately, as we do our auxiliary verbs in English, and would have been written in the same manner if words had been then distinguished in writing.

st fu- t.

The present first future occupied the same place which it now does, and concurred in its turn to complete the future in conjunction with the radix or root. That the substantive verb was inflected in the manner above explained, is obvious from its future middle εσομαι, and also from the future of the Latin verb *sum*, which was of old *eso*, *esis*, &c. Verbs in λω, μω, νω, ρω, often take σω in the first future.[1] Verbs in λω and ρω assume σ by analogy, as κελλω, κελσω, Eurip. *Hecub.* v. 1057. κελσαι, Hom. *Odyss.* x. v. 511. τελλω, τελσω, *unde* τελσον, *Il.* x. v. 707. ορω. ορσομεν, Pind. *Nem. Od.* 9. Duodec. 2. τειρω, τερσει, Theoc. *Idyll.* 22. v. 63. In fine, the Æolic dialect after the liquids often inserted σ.

It must be observed, that the Greeks, in order to accelerate the pronunciation, always throw out the ϵ and ο, except in verbs ending in αω, εω, οω, where they generally change them into η and ω. When the last letter of the radix can coalesce with σ after ϵ is thrown out, they transform it, so as to answer that purpose; but if not, they sometimes throw it out. We shall once more take λεγω as an example:

λεγ-εσω, λεγ-εσεις, λεγ-εσει, &c.

Throwing out ϵ, it would stand as λεγ-σω, λέγ-σεις, λεγ-σει, and by changing γs into ξ it becomes λεξω. Δθ and σ cannot coalesce with σ, therefore they are thrown out. Thus, Αδω, first future ασω; πληθω, first future πλησω; ἀνυτω, ἀνυσω, and the like.

Pr ite ten

These are the general rules with respect to the formation of the present and future of active verbs in the earliest stages of the Greek language. The limits prescribed to us will not allow us to pursue these conjectures; but the reader may, if he thinks proper, carry them a great way. The preterite tense falls next under consideration. If we may trust to analogy, this, as well as the other two, must have owed its confirmation to the radix of the verb, and some other word fitted to eke out its terminations. It has been thought by some critics, that this addition was taken from the Hebrew word חית; and we should be of the same opinion were it not that another auxiliary presents itself nearer home, and appears much more congruous to such a purpose. Perhaps, indeed, the people from whom we suppose it to have been borrowed, derived it from the eastern nations. We have already observed, that the Thracians were masters of a great part of Greece in the most remote ages. At that time they were a polite and learned people; and from them a considerable part of the Greek language was derived. If, therefore, we should find a word in their language employed for the same purpose, and accommodated to coalesce with the radical verb, we would feel ourselves very much inclined to prefer such a word.

The auxiliary verb.

The word *ha* pervades many different languages as an auxiliary verb. From it we have the Italian *ho*, the Spanish *he*, the French *ai*; and in one shape or other it appears in all the German and Scandinavian dialects. It is the Gothic auxiliary; and, we believe, it forms the termination of the perfect active of the first conjugation in the Latin tongue. For there *am* is the radix of *amo*, which has in the preterite *am-avi*, *amavi*, and in the preterperfect *am-hav-eram*, *amaveram*, compounded of *am*, *hav*, and *eram*, the imperfect of the indicative of the substantive verb. This process, in the formation of the preterite of Latin verbs, will scarcely be questioned, and forms certainly a presumptive proof that the Greeks pursued the same course. From this verb is likewise derived the Latin *habeo*, by changing *v* and *b*, which are indeed the same letter. Our readers, after this detail, will not be surprised if we should now hazard a conjecture, and declare it to be our opinion, that this same Gothic auxiliary *ha* is actually the additional part of the preterite of Greek verbs, indeed that part upon which the conjugation depends.

In forming this combination between the radix and the auxiliary, the Grecks were obliged to employ several devices. As often as the last letter of the radix could not unite with the aspirate in *ha*, they metamorphosed it into one of the double letters, which are capable of coalescing with it. In the verb λεγω, γ was changed into χ; thus λεγ *ha* became λεχα, τυπτω preterite τυπ *ha*, was combined into τυφα. In verbs having a radix which would not admit of this conjunction, they hardened the *h* into κ, as in τιω, preterite τι-κα, ἀκου-κα. Many other ways were contrived to facilitate this re-union; but these are detailed in every Greek grammar, and so need not be mentioned. What has been said with respect to this configuration, we offer as a pure conjecture, without the most remote intention of obtruding it upon our readers.

If it be admitted, that the auxiliary *ha* formed the conjugating termination of the active verb amongst the Greeks, it will likewise be admitted, that the radical verb and the other formed originally two distinct words, and that, according to this scheme, the preterite would proceed thus: λεγ *ha*, said *I have*; λεγ *has*, said *thou hast*; λεγ *he*, said *he hath*, and so on. This process appears to us rational, elegant, and advantageous. The pluperfect was not then invented, and therefore it does not come under our consideration. The other tenses were all deduced from those described; and in forming these intermediate distinctive tenses, we believe that both critics and grammarians, and perhaps philosophers too, were employed. See the article GRAMMAR.

The eastern nations have diversified their verbs, by affixing fragments of the personal pronouns to the radix, by which means they gained only the advantage of exhibiting the genders of the persons engaged in being, acting, and suffering; but a perpetual repetition of these became unavoidable. The Greeks, by their artificial combination of the radix with the two auxiliaries, avoided the necessity of repeating their personal pronouns, as we and the other modern inhabitants of Europe are now obliged to do; and at the same time, by diversifying the terminations of their nouns and verbs, they wonderfully improved the beauty and harmony of their language. The arrangement above insisted on is so very different from that of the orientals, and so entirely Gothic, that we think there can be no doubt of the Greeks having borrowed this device from the Thracians. Every person who is moderately acquainted with the Greek language will, upon examination, discover a wonderful coincidence between the structure, idioms, and phraseology, of the English and the Greek; and so many congenial features must engender a strong suspicion that there once subsisted a pretty intimate relation between them.

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[1] See *Fœd. Cret. ap. Marm. Oxon.* lib. 87.

In the preceding deduction, we have found ourselves obliged once more to differ from the very learned author of the *Origin and Progress of Language*. As we took the liberty to question his originality of the Greek language, and at the same time presumed to attack the goodly structure raised by philosophers, critics, and grammarians; so we now totally differ from that learned writer respecting his theory of the creation of verbs out of the inhabile matter of αω, εω, &c. This whole fabric, in our opinion, leans upon an insecure foundation. The apparatus of intermediate tenses, of augments, derivation of tenses, with their formation, participles, idiomatical constructions, and other essentials or appendages, we omit, as not coming within the scope of this disquisition.

Derivation and formation of the middle voice.

The derivation and formation of the middle and passive voices, would certainly afford matter of curious speculation; but the labour necessary to investigate this connection would greatly overbalance any benefit to be expected from the exposition of it. However, in order to complete our plan, we shall subjoin a few strictures respecting the formation of the middle voice, which, in our opinion, was immediately formed from the active. We have already seen, that the active voice, in its original state, was formed by annexing fragments of the substantive or auxiliary verb to the radix. The same economy has been observed in fabricating the flexible parts of the verb of the middle voice. To demonstrate this, we shall first conjugate the present tense of the auxiliary passive upon the principles above laid down.

Present, Εομαι, εεσαι, εεται, εομεθα, εεσθε, εονται. Such was the passive present of the auxiliary. We shall now take our example from the verb τυπτω; second future τυπ-εομαι, *struck I am*, τυπ-εεσαι, *struck thou art*, τυπ-εεται, *struck he is*, &c. contracted τυπουμαι, τυπη, τυπειται. The conjunction and formation here are obvious. Perhaps, in the second person, σ was inserted, which, however, is thrown out in the process of the persons. The future middle is clearly formed, by affixing the future-passive of the verb ἑω, only as η was introduced into the language for ε long, it was generally[1] substituted instead of that vowel in verbs ending in αω and ω, and ω for ο in verbs ending in οω; the two vowels ε and ο being originally long as well as short, till η was adopted to denote the long sound of the former, and ω that of the latter. In many verbs, before the conjunction of the radix and auxiliary, ε was thrown out. Thus, τυπ-εσομαι, became τυψομαι, λεγ-εσομαι, λεξομαι, &c.

Pl. CCCCIX.

The preterite was deduced from that of the active by a very slight variation, so trifling, indeed, that it need not be mentioned; only we may observe, that the aspirate *h* is never retained in this tense, which originally seems to have been the only distinguishing character by which that tense of the middle voice differed from the same tense of the active.

From the strict analogy between the mode of forming the three primary tenses of the active and middle voice, we are led to suspect that what is now the middle was originally the passive voice. The immediate formation of the former, by annexing the passive auxiliary, is obvious. The middle voice still partakes of the passive signification, since it has sometimes a passive, though more frequently an active sense. There are several parts of the present passive quite analogous to the same tenses in the middle; and, lastly, it is the common progress, in the course of improvement, to proceed step by step, and by approximation. What is most simple and easy is the first object, then succeeds what is only a little more difficult, and so on until we arrive at the last stage, when human ingenuity can proceed no farther. Now, it will readily be admitted, that the passive voice is much more embarrassed and intricate in its texture than the middle; and, therefore, the former should have been posterior in the order of time to the latter.

We are very well aware, that the learned Kuster, and indeed many other moderns, deeply skilled in the origin, progress, and structure, of the Greek language, have thought otherwise. The general opinion has been, that the Greek middle voice answered exactly to the Hebrew conjugation *hithpahel*, and in its pristine signification imported a reciprocality, or when the *agent acts upon itself*. But for our part, we only intended a few hints upon the subject, which our learned readers may pursue, approve, or reject, at pleasure.

Of the passive voice.

Next, if we might pretend to investigate the formation of the passive voice, we should imagine that the modern present was formed from the ancient one, by inserting such letters as were found necessary for beauty, variety, and energy; the first future from the second future middle of the verb τιθημι, once ϑεω. This future is θησομαι, and, joined to the radix, always occupies that place, τι-θησομαι, τελεθησομαι, φλεχθησομαι, τυφθησομαι, and so of the rest; but whether μαι, σαι, ται, which occur so frequently as the terminations of the middle and passive voices, are fragments of some obsolete verb, we will not pretend to determine. From verbs in αω, εω, οω, υω, are formed verbs in μι; which in the present, imperfect, and second aorist, as it is called, have only a different form, by assuming μι with a long vowel preceding it, in the present active, which vowel is preserved in each person singular. This collection of irregular verbs seems to be formed from the verb ειμι, which in some dialects might be ημι. Indeed the imperfect ην, ης, η, seems to imply as much; but in this we cannot venture to be positive.

In the whole of this analysis of the formation of verbs, we have only laid down what appears to us most plausible. That metaphysical critics may discover inaccuracies in the preceding detail we make no doubt; but our candid readers will doubtless reflect, that no language was ever fabricated by philosophers, and that the elements of speech were hammered out by peasants, perhaps even by savages. Critics have created a philosophy of language, we admit, and have a thousand times discovered wonderful acuteness and ingenuity in the mechanism of words and sentences, where the original onomathetæ never apprehended any, and which possibly never existed except in their own imagination. If our more enlightened readers should find any thing in the preceding detail worthy their attention, so much the better; but if the contrary should happen, we presume they will adhere to the hackneyed system. We have all along neglected the dual number, because it regularly follows the type of the other numbers.

Before we take leave of this subject, however, we must use the freedom to subjoin an observation or two respecting the consequences of the practice of new-modelling the present, and of course the imperfect, tenses of verbs. First, after this arrangement had been made, the Greeks commonly retained all the other tenses exactly as they had stood connected with the primitive verb. This needs no example. Secondly, they often collected the tenses of verbs, the present and imperfect of which were now obsolete, in order to supply this defect. Thus we have φερω, ὀισιω, ἐνεγκα, ἠνοχα. Thirdly, they often formed the present and imperfect tenses without any other tenses annexed; and the poets in particular seem to have fabricated these two tenses at pleasure.

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[1] We say generally, because in verbs ending in εω, the ε is sometimes retained, as τελεω-τελεσω, ἀρκεω-ἀρκεσω.

But if this procedure was convenient for the poets, it was certainly most incommodious with respect to the vulgar, as well as to all foreigners who had an inclination to learn the language. The vulgar, some ages after Homer and Hesiod, must have found it as difficult to understand their poems as our people do to comprehend those of Chaucer and Spenser. By this disposition, too, the etymology of verbs was almost entirely confounded. The present second future being, as has been observed, the ancient present, the attention of the curious etymologist was naturally diverted to the modern present, where it was utterly impossible to discover the radical word. A few examples will elucidate this point: τεινω, *to stretch, to extend*, old present τανω. Ταν is the radix, which at once appears to be a Persian word signifying *a large tract of country*. Hence *Mauritania*, the land of the Mauri, Aquitania, Britannia; and with the letter *s* prefixed, Hindu-stan, Chusi-stan, Turque-stan. The obsolete verb ὀπω, whence ὀπτομαι, is evidently derived from *op*, an Egyptian name of the moon; φαινω, second future φανῶ, *to show*, from the Egyptian word *phan* or *pan*, a name of the sun; τυπτω, future second τυπῶ, τυπ being obviously the offspring of תפ, *thaph*, a drum or timbrel, from beating or striking. In such etymological researches, the student must be careful to turn the Ionic η into the Doric α; because the Dorians came latest from the coast of Palestine, and consequently retained the largest share of the Phœnician dialect. Thus, γηθεω, *to rejoice*, turning η into α becomes γαθεω. This word, throwing away the termination, becomes *gath*, plainly signifying a *wine press*.[1] It is likewise to be observed, that the Æolians often changed α into υ, as συρξ instead of σαρξ, &c.

Greek infinitives used as nouns.

It is not our intention to enter at length into the arrangement and peculiar construction of the Greek language. There is one point, however, which we cannot well pass over in silence. As that tonguc is destitute of those words which the Latins call *gerunds*, to supply this defect they employ thc infinitive with the article prefixed: thus, Εἰς το εἰναι αὐτους φιλους, *in order to their being friends*; ἀπο του ἑλεσθαι αὐτους Βασιλεα, *from their having elected a king*; Ἐκ του ἀποφευγειν αὐτους ἐκ της πολεος, *from their flying out of the city*. In these phrases the infinitive is said to assume the nature of a substantive noun, agreeing with the article before it, exactly as if it were a noun of the neuter gender. Idioms of this kind occur in our own tongue; only with us the verb, instead of being expressed in the infinitive, is turned into the participle. According to this arrangement, the first of the preceding phrases, which, according to the Greek, would stand *toward to be friends*, in English is, *in order to their being friends*. This anomaly, then, if indeed it be such, is of no manner of consequence. The French, if we are not mistaken, would express it in the very same manner with the Greek, that is, *pour être amis*.

From treating of verbs, we should naturally proceed to the consideration of adverbs, which are so denominated, because they are generally the concomitants of verbs. Every thing relating to that part of speech, in the Greek tongue, may be seen in the Port Royal or any other Greek grammar. Instead, therefore, of dwelling upon this exhausted topic, we shall hazard a conjecture upon a point to which the critics in the Greek language, as far as we know, have not hitherto adverted.

Greek particles of oriental extraction.

The most elegant and most admired writers of Greece, and especially Homer, and after him Hesiod, abound with small particles, which appear to us pure expletives, created as it were to promote harmony, or fill up a blank without sense or signification. How these expletive particles should abound in that language beyond any other, is a matter which it does not seem easy to account for. It has been said by thc Zoiluses, that if you extract these nonentities from the poems of that bard, *qui solus meruit dici poeta*, a *magnum inane*, a mighty blank would remain behind. We would willingly do justice to that pigmy race of words, and at the same time vindicate the prince of poets from such a groundless imputation. Plato likewise, the prince of philosophers, has often been accused of too frequently employing these superfluous auxiliaries.

The particles in question were no doubt imported from the East. It would be ridiculous to imagine that any description of men, however enthusiastically fond they might be of harmonious numbers, would sit down on purpose to fabricate a race of monosyllables purely to eke out their verses, mere sounds without significance. In the first place, it may be observed, that there is a very strict connection amongst the particles of all cognate languages. To this we may add, that the not understanding the nature, relations, significations, and original import of those seemingly unimportant terms, has occasioned not only great uncertainty, but numberless errors in translating the ancient languages into the modern. The Greek language in particular loses a considerable part of its beauty, elegance, varicty, and energy, when these adverbial particlcs with which it is replete are not thoroughly comprehended. An exact translation of these small words, in appearance insignificant, would throw new light not only upon Homer and Hesiod, but even upon poets of a much posterior date. Particles, which are generally treated as mere expletives, would often be found energetically significant. It is, however, altogether impossible to succeed in this attempt without a competent skill in the Hebrew, Chaldaic, Arabian, Persian, and ancient Gothic languages.

We shall here take the liberty to mention a few of thosc particles which are most familiar to us, one or other of which occur in almost every line of Homer, and which wc believe are either not understood at all, or misunderstood. Such are Δα, δη, μεν, ηντοι, μαν, γε, ερι, αρα, ρα, γουν. Δα is nothing else but the Chaldaic particle δα, the parent of the English *the*. It likewise signifies *by turns*, or *in your turn*. Δη is the same word in the Ionic dialcct; μεν is a particle of the Hebrew affirmative אמן, *amen, fides, veritas*. Μαν is a kind of oath by the moon, called *mana*, almost over all the East, and hence *Dorice* μανα; γε, an oath by γεα, that is, *the earth*; αρα, another oath by the same elcment, probably from the oriental word of the same import; ρα is a fragment of αρα mentioned before; γουν, of γεα, *the earth*; ου or ων, an Egyptian name of the sun; and ως, *as*, a particle which pervades all the dialects of the Gothic language. In this manner we believe all these small words which occur so frequently in the Greek tongue, and which have hitherto been held as inexplicable, may easily bc rendered in significant terms; and werc this done, we believe they would add both beauty and energy to the clauses in which they stand. But this discussion must be left to more accomplished hellenists.

Prepositions.

We need not explain the nature of prepositions, because we are convinced that fcw people will take the trouble to peruse this disquisition who are not already acquainted with their import in language. The Greek prepositions, which are eighteen in number, need not be cnumerated here. Most of them might easily be shown to be particles, or fragments deduced from oriental or Gothic words. The usc of these words is to connect together terms in discourse, and to show the relation bctween them. In languages where, as in English, all these relations are expressed without any change on the termination of the nouns to which they are prefixed, the process is natural and easy. The whole is performed by juxtaposition. But in the Greek and Latin tongues, this effect is produced, partly by prefixing prepositions and partly by varying the terminations of nouns. Had the Greeks been able to intimate all these relations by varying the terminations, or had they multiplied their prepositions to such a number as would have enabled them to express these relations without the casual variations, as the northern languages have done; in either case their language would have been less embarrassing than it is in its present state. According to the present arrangement, both prepositions and the casual variations are used promiscuously to answer that purpose, a method which appears to be not altogether uniform. Though this plan might occasion little embarrassment to natives, it must, in our opinion, have proved somewhat perplexing to foreigners. In the case of the latter, the difficulty would be when to adopt the one and when the other expedient.

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[1] Hence it came to signify rejoicing, from the mirth and revelry attending the treading of the vine-press.

Another inconvenience arises from the exceedingly small number of prepositions in that language, which indeed bear no adequate proportion to the great variety of relations they are appropriated to express. This deficiency obliged them frequently to employ the same preposition to denote different relations. For instance, ἐπι intimates, 1st, *upon*, as ἐπι του λιθου, *upon the stone*; and then it takes the genitive. 2d, It denotes *near upon*, as ἐπι τῳ λιθῳ; and then it governs the dative. 3d, The same preposition signifies *motion towards*, as ἐπεσεν ἐπι τον λιθον, *he fell upon the stone.* In these instances the same preposition intimates three different relations; and, which is still more embarrassing, each of these requires a different case. The difficulty in this instance is so considerable, that even the most accurate of the Greek writers themselves often either forget or neglect the true application. Many examples of this might be produced, did the limits assigned us admit of such illustrations. Every man who has carefully perused the Grecian authors will readily furnish himself with examples.

Again, some prepositions indicating different relations, are nevertheless prefixed to the same case. Thus, ἐξ signifies *from*, as, 'Εκ Διος ἀρχομεθα, *from Jupiter we begin*; ἀπ ἐμου βιου, *from my life*, or *my course of life*; προ των θυρων, *before the doors*; προ νικης ἐγκωμιον, *an encomium before the victory*; ἀντι ἀγαθων ἀποδιδοναι κακα, *to render evil for good*; ἀντι σου, *against you.* In these examples, and indeed every where, the propositions employed intimate different relations, and yet are prefixed to the same cases. Sometimes the same preposition would seem to assume two opposite significations, as appears from the preposition ἀντι just mentioned, which intimates both *for*, *instead of*, and *against* or *opposite to*.

What has been observed with respect to the prepositions above mentioned, the reader will readily enough apply to κατα, μετα, δια, περι. These incongruities certainly imply something irregular, and appear to intimate that those anomalies were so deeply incorporated with the constitution of the language, that the subsequent improvers found it impossible to correct them. Indeed, to prefix a preposition to a case already distinguished by the affixed termination, appears to us a superfluity at least, if not an absurdity; for certainly it would have been more natural to have said ἐκ Ζευς ἀρχομεθα, than ἐκ Διος ἀρχομεθα. Some very learned men, who have inquired into the origin of language, have been of opinion that prepositions formed the last invented species of words. If this opinion be well founded, we may suppose (and we think that such a supposition is not altogether improbable) that the casual terminations of the Greek language were first affixed to the radix, in the manner above exhibited; and that prepositions were afterwards fabricated and prefixed to the cases already in use.

The syntax or construction of the Greek language does not, according to our plan, come within the compass of our present inquiry. This the curious Greek student will easily acquire, by applying to the grammars composed for that purpose. We have already hazarded a few conjectures respecting the formation of the most important and most distinguished classes of words into which it has been divided by the most able grammarians, without, however, descending to the minutiæ of the language. But as prepositions are the chief materials with which its other words, especially verbs, are compounded, we shall briefly consider the order in which they probably advanced in this process of composition.

Complex ideas are compounded of a certain number or collection of simple ones. Of those complex notions, some contain a greater and others a smaller number of simple conceptions. In language, then, there are two ways of expressing such complex ideas; either by coining a word to express every simple idea separately, according to the order in which they stand in the mind; or by trying to combine two or more simple terms into one, and by this method to intimate one complex idea by one single word. The Arabians, notwithstanding all the boasted excellencies of their language, have never arrived at the art of compounding their words, in order to answer this noble purpose; and the sister dialects are but slenderly provided with this species of words. The Greeks, of all other nations, excepting perhaps those who spake the Sanscrit language, are unrivalled in the number, variety, propriety, elegance, energy, and expression of their compound terms. The Greeks, like the Arabians, in the earliest stages of their language, had only a collection of disjointed radical words, consisting of the jargons of the aboriginal Greeks, of the Pelasgi, Thracians, and others. How these words were arranged and constructed, we have no data remaining upon which we can found a critical investigation. We must therefore remain satisfied with such probable conjectures as the nature of the case, and the analogy of the language, seem to suggest.

The prepositions were originally placed before the nouns, the relations of which they pointed out. For example, let us take the ξυναπεθνησκετο τοις ἀλλοις, he died along with the rest, or he died out of hand along with the others. These words were arranged thus; ἀπεθνησκετο συν τοις ἀλλοις, and ἀποθνησκον συν τοις αλλοις. In this manner the parts of every compound word were placed separately, at least as much as other words which had no connection.

The firs compoun words in Greek.

The first compound words of the Greek language were those of the radical nouns with the article, and the radical part of the substantive or auxiliary verb. The success of this experiment encouraged them to attempt the same thing in other words. By this noble invention they found themselves able to express, in one word, with ease and significancy, what in other languages, and formerly in their own, required a tedious ambages or circumlocution. In process of time, as their language was gradually mellowed, they increased the number of their compounds, until, in this respect, the Greek infinitely excelled all its parent dialects. In this process they were careful to unite such letters as not only prevented asperity and difficulty of pronunciation, but even promoted harmony and elegance. But this was the labour of posterior ages.

The Greeks were entirely ignorant of the derivation or etymology of their language. For proof of this we need only consult Plato's *Cratylus*, Aristotle's *Rhetoric*, Demetrius Phalereus, Longinus, and others. But in deducing patronymics, abstracts, possessives, gentiles, diminutives, verbals, and the like, from radicals of every kind, they have shown the greatest art and dexterity. Examples of this occur almost in every page of every Greek author. But this extended no farther than their own language; every foreign language was an abomination to the Greeks.

Origina material of the Greek l guage.

The original materials of the Greek tongue were undoubtedly rough and discordant, as we have above described them. They had been collected from different quarters, they were the produce of different countries, and had been imported at very distant periods. It would therefore be an entertaining, if not an instructive, speculation, if it were possible to discover by what men and by what means, this wonderful fabric was founded, erected, and carried to perfection. The writers of Greece afford us no light on this matter. Foreigners were unacquainted with that originally insignificant canton. Every thing beyond Homer is buried in eternal oblivion. Orpheus is indeed reported to have composed poems; but these were soon obliterated by the hand of time. The verses which have been ascribed to that philosophical hero are none of his.[1] Linus wrote, in the Pelasgic dialect, the achievements of the first Bacchus; Thamyris the Thracian was also the author of verses; and Pronapides the master of Homer was a celebrated poet. But the works of these bards did not long survive; and it is a certain fact that the Greek tongue was highly polished even more early than the age in which these worthies flourished. Homer, no doubt, imitated their productions, and some are of opinion that he borrowed liberally from them. The Greeks knew no more of the original character of their language, than of the original character and complexion of their progenitors. They allowed, indeed, that their language was originally barbarous and uncouth; but by what means or by what persons it was polished, enriched, and finally arranged, remained to them an impenetrable secret.

I as carri to its u ost perfe on at a v early p d.

We have already demonstrated that the Ionim or aborigines of Greece were a race of barbarians; that consequently their language, or rather their jargon, was of the same contexture. The Pelasgians found both the people and their speech in this uncultivated state. These people arrived in Greece about the year before Christ 1760. It was then that the language of Greece began to be cultivated. Before the age of Homer the work seems to have been completed. Nothing of consequence was afterwards added to the original stock; on the contrary, not a few varieties were deducted from the Homeric treasure. The Pelasgians, as was said before, arrived in Greece 1760 B.C. Homer is thought to have been born in 1041 B.C.; consequently the cultivation of the Greek tongue was completed in a period of about seven hundred years. But upon the supposition that Orpheus, Linus, Thamyris, and others, wrote long before Homer, as they certainly did, that language had arrived nearly at the standard of perfection two centuries before; and by this computation the period of its progress towards its stationary point is reduced to five hundred years. But as the Pelasgians were a colony of foreigners, we ought to allow them one century at least to settle and incorporate with the natives, and to communicate their language, laws, manners, and habits, to the aborigines of the country. By this deduction we shall reduce the term of cultivation to less than four centuries.

During this period Greece was furiously agitated by tumults and insurrections. That country was divided into a number of independent states, which were perpetually engaged in quarrels and competitions. The profession of arms was absolutely necessary for the protection and preservation of the state; and the man of conduct and prowess was not only honoured as a demi-god, but his exploits were transmitted with eclat to posterity. The Greek tongue was then rough and unpolished; because, like the ancient Romans, the bravest men were more disposed to act than to speak. Every language will take its colour from the temper and character of those who employ it; and had it not been owing to one class of men, the Greek tongue would have continued to the era of Homer as rude as it had been a century after the arrival of the Pelasgians.

There has appeared amongst barbarous or half civilized people a description of men whose profession it has been to frequent the houses or palaces of the great, in order to celebrate their achievements, or those of their ancestors, in the sublimest strains of heroic poetry. Accordingly, we find that the Germans had their bards, the Gauls their fads, the Scandinavians their scalds, and the Irish their fileas, all retained for that very purpose. They lived with their chieftains or patrons, attended them to battle, were witnesses of their heroic deeds, animated them with martial strains, and celebrated their prowess, if they proved victorious; or, if they fell, raised the song of woe, and chanted the mournful dirge over their sepulchres. These bards were always both poets and musicians. Their persons were held sacred and inviolable. They attended public entertainments, and appeared in all national conventions. The chief of them were employed in the temples of the gods; and the less illustrious, like our minstrels of old, strolled about from place to place, and exercised their functions wherever they found encouragement.

Amongst the ancient Greeks there was a numerous tribe of men of the very same description who were at once poets and musicians, and whose office it was to celebrate the praises of the great, and to transmit their exploits to posterity with the most exaggerated encomiums. These poetical vagrants were styled Αοιδοι, or songsters. Some of them lived in the houses of great men; whilst others, less skilful or less fortunate, strolled about the country in the manner above described. The more illustrious of these Αοιδοι, who were retained in the temples of the gods, were certainly the first improvers of the language of the Greeks. Amongst the Hebrews we find that the first poetical compositions were hymns in honour of Jehovah; and amongst the pagans the same practice was established. In Greece, when all was confusion and devastation, the temples of the gods were held sacred and inviolable. There the Αοιδοι improved their talents, and formed religious anthems upon those very models which their progenitors had chanted in the East.

Distinction between the language of gods and of men.

The language of the Greeks being yet rugged and unmellowed, their first care was to render it softer and more flexible. They enriched it with terms suited to the offices of religion; and these, we imagine, were chiefly imported from the East. Homer every where mentions a distinction between the language of gods and men. The language of gods imports the oriental terms retained in the temples, and used in treating of the ceremonies of religion; the language of men intimates the ordinary civil dialect which sprung from the mixed dialects of the country. The priests no doubt concurred in promoting the noble and important purpose. From this source the strolling Αοιδοι drew the rudiments of their art; and from these songsters, again, the vulgar deduced the elements of a polished style.

To the Αοιδοι of the superior order we would venture to ascribe those changes mentioned in the preceding part of this inquiry, by which the Greek tongue acquired that variety and flexibility, from which it has in a great measure derived that ease, beauty, and versatility, by which it now surpasses most other languages. The diversity of its terminations furnishes a most charming variety, whilst at the same time the sense is communicated to the reader or hearer by the relation between them. By this economy the poet and the orator are left at liberty to arrange their phrases in that order which may be most soothing to the ear, and best adapted to make a lasting impression on the mind.

Few colonies have emigrated from any civilized country without a detachment of priests in their train. The supreme powers, whoever they were, have always been worshipped with music and dancing. The Hebrews, Phœnicians, and Egyptians, delighted in these musical and jocund festivals. The priests who attended the Ionians, Dorians, Æolians, Thebans, Athenians, &c. from the East, introduced into Greece that exquisite taste, and those delicate musical feelings, which distinguish the Greeks from all the neighbouring nations. Hence the numerous progeny of onomatapœas, by which the Greek language is invested with the power of expressing almost every passion of the human soul, in such terms as oblige it to feel and actually to assimilate to the passion it would excite. Numberless instances of this occur in every page of Homer, Hesiod, Pindar, Sophocles, Euripides, and even of Aristophanes; but to quote instances would be to insult the student of Greek.

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[1] Pausanias, lib. i. cap. 22.

Every body knows that the practice of writing in verse was antecedent to the epoch of prosaic composition. Here, then, the Αοιδοι and the ministers of religion chiefly displayed their skill and discernment. By a judicious mixture of short and long syllables, by a junction of consonants which naturally slide into each other, and by a careful attention to the rhythm, or harmony resulting from the combination of the syllables of the whole line, they completed the metrical tone of the verse, guided by that delicacy of musical feeling of which they were possessed before rules of prosody were known amongst men.

Much liberty was certainly used in transposing letters, in varying terminations, and also in annexing prefixes and affixes, both to nouns and other kinds of words where such adjuncts were possible; and upon this occasion we think it probable, that those particles of which we have already spoken were inserted like filling stones thrust in to stop the gaps or chinks of a building. Verses were then clumsy and irregular, as the quantity of vowels was not duly ascertained, and the collision of heterogeneous consonants not always avoided. Probably these primitive verses differed as widely from the finished strains of Homer and his successors, as those of Chaucer and Spencer do from the smooth and polished lines of Dryden and Pope.

Earliest poets of Greece.

The poetical compositions of the earliest Greeks were not, we think, in the hexameter style. As they were chiefly calculated for religious services, we imagine they resembled the Hebrew iambics preserved in the song of Aaron and Miriam, Deborah and Barak, Psalms, Proverbs, &c. which were indeed calculated for the same purpose. Archilochus perhaps imitated these, though the model upon which he formed his iambics was not generally known. The later dramatic poets appear to have copied from the same archetypes. Hexameters, it is probable, were invented by Orpheus, Linus, Thamyris, Musæus, and their contemporaries. The first of these travelled into Egypt, where he might learn the hexameter measure from the people of that country, who used to bewail Maneros and Osiris in elegiac strains. This species of metre was first consecrated to theology, and the most profound sciences of moral and natural philosophy; but at length it was employed to celebrate the exploits of kings and heroes.

> Res gestas regumque, ducumque, et fortia bella,
> Quo scribi possent numero monstravit Homerus.

Orpheus, &c.

We have hazarded a conjecture above, importing that the earliest poetical compositions of the Greeks were consecrated to the service of the gods. We shall now produce a few facts, which will furnish at least a presumptive evidence of the probability of this conjecture.

Orpheus commences his poem with ancient chaos, its transformations and changes, and pursues it through its various revolutions. He then goes on to describe the offspring of Saturn, that is time, the æther, love, and light. In short, his whole poem is said to have been an oriental allegory, calculated to inspire mankind with the fear of the gods, and to deter them from murder, and rapine, and unnatural lusts. Musæus was the favourite scholar of Orpheus, nay perhaps his son. He composed prophecies and hymns, and wrote sacred instructions, which he addressed to his own son. He prescribed atonements and lustrations; but his great work was a Theogony, or History of the Creation. Melampus brought from Egypt into Greece the mysteries of Proserpine. He wrote the whole history of the disasters of the gods. This seer is mentioned by Homer himself. Olen came from Lycia, and composed the first hymn which was sung in Delos at their solemnities; he probably emigrated from Patara a city of Lycia, where Apollo had a celebrated temple and oracle. The Hyperborean damsels used to visit Delos, where they chaunted sacred hymns in honour of the Delian god. To these we may add the great Homer himself, if indeed the hymns commonly annexed to the Odyssey are his composition. Hesiod's Theogony is too well known to require any description. From these instances it appears, that the origin of the poetry of Greece is to be found in the temples; and that there, its measure, numbers, rhythm, and other appendages, were originally fabricated.

Different dialects, with thei origin.

The Grecian poets, however, enjoyed another advantage which that class of writers have seldom possessed, and which arose from the different dialects into which their language was divided. All these dialects were adopted indifferently by the prince of poets; a circumstance which enabled him to take advantage of any word from any dialect, provided it suited his purpose. This, at the same time that it rendered his versification easy, diffused an agreeable variety over his composition. He even accommodated words from Macedonia, Epirus, and Illyricum, to the purposes of his versification. Besides, the laws of quantity were not then clearly ascertained; and this circumstance afforded him another convenience. Succeeding poets did not enjoy these advantages, and consequently have been more circumscribed both in their diction and their numbers.

The Greek language, as is generally known, was divided into many different dialects. Every sept, or petty canton, had some peculiar forms of speech which distinguished it from the others. There were, however, four different dialetical variations which predominated over all the others; namely, the Attic, Ionic, Æolic, and Doric. These four dialetical distinctions originated from the different countries in the East whence the tribes respectively emigrated. The Attics consisted, first, of the barbarous aborigines; secondly, of an adventitious colony of Egyptian Saïtes; thirdly, a branch of Ionians from the coast of Palestine. These last formed the old Ionian dialect, from which sprung the Attic and the modern Ionic. The Æolians emigrated from a different quarter of the same coast, the inhabitants of which were a remnant of the old Canaanites, and consequently different in dialect from the two first-mentioned colonies. The Dorians sprang from an unpolished race of purple-fishers on the same coast, and consequently spoke a dialect coarser and more rustic than any of the rest. These four nations emigrated from different regions; a circumstance which, in our opinion, laid the foundation of the different dialects by which they were afterwards distinguished.

It is impossible in this short sketch to exhibit an exact view of the distinguishing features of each dialect. Such an analysis would carry us far beyond the limits assigned to the present article. For entire satisfaction on this head, we must refer the Grecian student to Mattaire's *Grecæ Linguæ Dialecti*, where he will find every thing necessary to qualify him for understanding that subject; and, in the meantime, we shall content ourselves with the few following observations.

The Athenians being an active, brisk, volatile race, delighted in contractions. Their style was most exquisitely polished. The most celebrated authors who wrote in that dialect were, Plato, Thucydides, Xenophon, Demosthenes, and the other orators; Æschylus, Euripides, Sophocles, Aristophanes, Menander, Diphilus, with the other comic and tragic poets. That dialect was either ancient or modern. The ancient Attic was the same with the Ionic.

The Ionic, as we have already said, was the ancient Attic; but when that nation emigrated from Attica and settled on the coast of Asia Minor, they mingled with the Carians and Pelasgians, and of course adopted a number of their terms. They were an indolent, luxurious, and dissolute people; and hence their style was easy and flowing, but verbose, redundant, and without nerve or vigour. This however, is the leading style in Homer; and after him a prodigious number of writers on every subject employed the same dialect, such as Herodotus of Halicarnassus the celebrated historian; Ctesias of Cnidus the historian of Persia and India; Hecatæus of Miletus; Megasthenes the historian, who lived under Seleucus Nicator; Hippocrates the celebrated physician of Coos; Hellanicus the historian often mentioned with honour by Polybius; Anacreon of Teia, Alcæus, Sappho of Lesbos, excellent poets; Pherecydes Syrus the philosopher, and a multitude of other persons of the same profession, whom it would be superfluous to mention on the present occasion.

The Æolic and the Doric were originally cognate dialects. When the Dorians invaded Peloponnesus, and settled in that peninsula, they incorporated with the Æolians, and their two dialects, blended into one, produced the new Doric. The original Dorians inhabited a rugged mountainous region about Ossa and Pindus, and spoke a rough unpolished language similar to the soil which they inhabited. Andreas Schottus, in his Observations on Poetry (lib. ii. cap. 50) proves from an old manuscript of Theocritus, that there were two dialects of the Doric tongue, the one ancient and the other modern; that this poet employed Ionic and the modern Doric; that the old Doric dialect was rough and cumbrous; but that Theocritus adopted the new as being softer and more mellow. A prodigious number of poets and philosophers wrote in this dialect, such as Epicharmus the poet; Ibycus the poet of Rhegium; Corinna the poetess of Thespis, or Thebes, or Corinth, who bore away the prize of poetry from Pindar; Erynna a poetess of Lesbos; Moschus the poet of Syracuse; Sappho the poetess of Mitylene; Pindar of Thebes, the prince of all lyric poets; Archimedes of Syracuse, the renowned mathematician, and almost all the Pythagorean philosophers. Few historians wrote in that dialect; or if they did, their works have not fallen into our hands. Most of the hymns chanted in temples of the gods were composed in Doric; a circumstance which evinces the antiquity of that dialect, and which, at the same time, proves its affinity to the oriental standard.

T parti- al of the G ks to th own to he.

After the Greek tongue had been thoroughly polished by the steps which we have endeavoured to trace in the preceding pages, conscious of the superior excellency of their own language, the Greeks, in the pride of their hearts, stigmatised every nation which did not employ their language with the contemptuous title of *barbarians*. Such was the delicacy of their pampered ears, that they could not endure the untutored voice of the people whom they called βαρβαροφωνοι. This extreme delicacy produced three very pernicious effects. First, it induced them to metamorphose and sometimes even to mangle, foreign names, in order to reduce their sound to the Grecian standard; and, secondly, it prevented their learning the languages of the East, the knowledge of which would have opened to them an avenue to the records, annals, antiquities, laws, and customs, of the people of those countries, in comparison of whom the Greeks themselves were of yesterday, and knew nothing. By this unlucky bias, not only they, but even we who derive all the little knowledge of antiquity which we possess through the channel of their writings, have suffered an irreparable injury. By their transformation of oriental names they have in a manner stopped the channel of communication between the histories of Europe and Asia. This appears evident from the fragments of Ctesias's Persian history, from Herodotus, Xenophon, and all the other Grecian writers who have occasion to mention the intercourse between the Greeks and the Persians. The same absurd prejudice deprived them of all knowledge of the etymology of their own language, without which it was impossible for them to understand thoroughly its words, phraseology, and idioms. We have mentioned above the Cratylus of Plato. In that dialogue, the divine philosopher endeavours to investigate the etymology of only a few Greek words; but his deductions are absolutely childish, and little superior to the random conjectures of a school-boy. Varro, the most learned of all the Romans, has not been more successful. Both stumbled on the very threshold of that useful science; and a scholar of very moderate proficiency in our days knows more of the origin of these two noble languages, than the greatest adepts amongst the natives did in theirs. By prefixes, affixes, transpositions of letters, and new conjunctions of vowels and consonants for the sake of the music and rhythm, they have so disguised their words, that it is now almost impossible to develope their original. As a proof of this, we remember to have seen in the hands of a private person a manuscript, in which the first twelve verses of the Iliad are carefully analysed; and it appears to our satisfaction, that almost every word may be, and actually is traced back to a Hebrew, Phœnician, Chaldean, or Ægyptian original. And we are convinced that the same process will hold good in the like number of verses taken from any of the most celebrated poets of Greece. This investigation was chiefly conducted by reducing the words to their original invariable state, which was done by stripping them of prefixes, affixes, and other adventitious elements.

Beauty of the Greek language.

These imperfections, however, are counterbalanced by numberless excellencies; and we are certainly much more indebted to that incomparable people for the information they have transmitted to us through the medium of their writings, than injured by them in not conveying to themselves and to us more authentic and more ample communications of ancient events and occurrences. Without fatiguing our readers with superfluous ecomiums on a language which has long ago been extolled perhaps to an extravagant degree by the labours of men of the greatest capacity and the most refined taste, we shall now proceed to make a few observations on *spirits* and *accents*, which, being rather appendages than essentials of the language, we have on purpose reserved for the last place.

The spirits

Every word in the Greek language beginning with a vowel is marked with a spirit or breathing; and this aspiration is double, namely, *lenis et asper*, the gentle, and rough or aspirated. The gentle accent, though always marked, is not now pronounced, though in the earliest periods of the language it was undoubtedly enounced, although very softly. Both these aspirations were imported from the East. They were actually the Hebrew ה *he* and ח *heth*. The former denoted the *spiritus lenis*, the latter the *spiritus asper*. The Hebrew prefixed *ha* or *he* to words beginning with a vowel, and of course the Greeks followed their example. This people appears to have delighted in aspirates; and consequently the letter ς is, some think, rather too often affixed to the terminations of their words. Every word beginning with ρ had the aspirate joined to ρ, probably with the design of rendering the aspiration still rougher.

The accents.

The Greek accents are three in number; the acute, the grave, and the circumflex. The acute raises and sharpens the voice; the grave depresses and flattens it; the circumflex first raises and sharpens the voice, and then depresses and flattens it. It is obviously composed of the other two. The learned author of the *Origin and Progress of Language* has taken much pains to prove that these accents were actually musical notes, invented and accommodated to raise, depress, and suspend the voice, according to a scale of musical proportions. It is scarcely possible, we think, for a modern Greek scholar to comprehend distinctly the ancient theory of accents. These the native Greeks learned from their infancy, and that with such accuracy, that even the vulgar amongst the Athenians would have hissed an actor off the stage or an orator off the pulpitum, on account of a few mistakes in the enunciation of these notes.

The elevations, depressions, and suspensions of the voice upon certain syllables, must have made their language sound in the ears of foreigners somewhat like recitative, or something nearly resembling *cant*. But the little variety of these syllabic tones, and the voice not resting upon them, but running them on without interruption, sufficiently distinguished them from music or cant. Be that as it may, we think it highly probable, that the wonderful effects produced by the harangues of the orators of Greece on the enraptured minds of their hearers, were in a great measure owing to the artificial musical tones by which their syllables were so happily diversified. To this purpose we shall take the liberty to transcribe a passage from Dionysius of Halicarnassus *De Structura Orationis*, which we find translated by the author of the *Origin and Progress of Language*, (vol. ii. part ii. chap. 7, p. 381.) "Rhetorical composition is a kind of music, differing only from song or instrumental music, in the degree, not in the kind; for in this composition the words have melody, rythm, variety, or change, and what is proper or becoming; so that in it, as well as in music, the ear is delighted with the melody, moved by the rythm, is fond of variety, and desires with all these what is proper and suitable. The difference, therefore, is only one of greater and less."

With respect to accents, it may be observed that only one syllable of a word is capable of receiving the acute accent, however many there be in the word. It was thought that the raising the tone upon more than one syllable of the word, would have made the pronunciation too various and complicated, and too like chanting. The *grave accent* always takes place when the acute is wanting. It accords with the level of the discourse; whereas the acute raises the voice above it. The *circumflex accent* being composed of the other two is always placed over a long syllable, because it is impossible first to elevate the voice and then to depress it upon a short one. Indeed amongst the Greeks a long syllable was pronounced like two short ones; and we apprehend it was sometimes written so, especially in later times. It is perfectly obvious from two learned Greek authors, Dionysius of Halicarnassus, and Aristoxenus, that the Greek accents were actually musical notes; and that these tones did not consist of loud and low, or simply elevating and depressing the voice, but that they were uttered in such a manner as to produce a melodious rythm in discourse. In a word, the acute accent might be placed upon any syllable before the antepenult, and it rose to a fifth in the diatonic scale of music, whilst the grave fell to the third below it. The circumflex was regulated according to the measure of both, the acute always preceding. The grave accent is never marked except over the last syllable. When no accent is marked, there the grave always takes place. Some words are called *enclitics*. These have no accent expressed, but throw it back upon the preceding word. The circumflex, when the last syllable is short, is often found over the penult, but never over any other syllable except the last or the last but one.

The ancient Greeks had no accentual marks. These modifications of voice they learned by practice from their infancy; and we are assured by good authority, that in pronunciation they observe them to this day. The accentual marks are said to have been invented by a celebrated grammarian, Aristophanes of Byzantium, keeper of the Alexandrian library under Ptolemy Philopater, and by Epiphanes, who is also supposed to have invented punctuation. Accentual marks, however, were not in common use till about the seventh century; at which time they are found in manuscripts.[1]

Such, in general, are the observations which we conceived that the nature of our design obliged us to make on the origin and progress of the Greek language. Some of our more learned readers may perhaps blame us for not interspersing the whole disquisition with quotations from the most celebrated writers in the language which has been the object of our researches; and we are well aware that this is the general practice in such cases. The books were before us, and we might have transcribed from them more quotations than the nature of an article of this kind would permit. In the first part there were no books in that language to quote from, because the Greeks knew nothing of their own origin, nor of that of their language, and consequently have recorded nothing but dreams and fictions in reference to that subject. Even when we had made considerable progress in our inquiry, the nature of the plan we had adopted excluded in a great measure the use of quotations. When we drew near the conclusion, we imagined that our learned readers would naturally have recourse to the passages alluded to without our information, and that the unlearned would not trouble themselves about the matter. The Greek student who intends to penetrate into the depths of this excellent language, will endeavour to be thoroughly acquainted with the books mentioned below.[2]

Vast extent of t Greek La guage.

We shall now subjoin a brief account of the vast extent of the Greek language even before the Macedonian empire was erected; at which period it became in a manner general, much more so, indeed, than ever the Latin language could accomplish notwithstanding the vast extent of the Roman empire.

Greece, originally Hellas, was a region of but small extent, and yet sent out numerous colonies into different parts of the world. These colonies carried along with them their native language, and industriously diffused it wherever they formed a settlement. The Ionians, Æolians, and Dorians, possessed themselves of all the west, and north-west coast of the Lesser Asia and the adjacent islands; and there even the barbarians learned the polished language of Greece. The Greek colonies extended themselves along the southern coast of the Euxine Sea as far as Sinope, now Trebizond, and all the way from the western coast of Asia Minor; and though many cities of barbarians lay between, the Greek tongue was understood and generally spoken by people of rank and fashion. There were also Greek cities on the northern coast of the Euxine Sea to the very eastern point, and perhaps beyond even those limits; likewise in the Taurica Chersonesus, or Crim Tartary; and even to the mouth of the Danube, the straits of Caffa, &c. In the neighbourhood of all these colonies, the Greek language was carefully propagated amongst the barbarians, who carried on commerce with the Greeks.

A great part of the south of Italy was planted with Greek cities upon both coasts, so that the country was denominated Magna Græcia; and here the Greek tongue universally prevailed. In Sicily it was in a manner vernacular. The Io-

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[1] If the curious reader should wish to enter more deeply into the theory of accents, we must refer him to *Origin of Language*, vol. ii. lib. 2. passim; and to Mr. Foster's *Essay on the different Nature of Accent and Quantity*.

[2] Aristotle's *Rhetoric and Poetics*, and his book *De Interpretatione*, especially with Ammonius's *Commentary*. Ammonius was a native of Alexandria, and by far the most acute of all the ancient grammarians. Dionysius of Halicarnassus *De Structura Orationis*, where, amidst abundance of curious and interesting observations, will be found the true pronunciation of the Greek letters. Demetrius Phalereus *De Elocutione*; a short essay indeed, but replete with instruction concerning the proper arrangement of words and members in sentences. Longinus, the prince of critics, whose remains are above commendation. Theodorus Gaza and the other refugees from Constantinople, who found an hospitable reception from the munificent family of the Medici, and whose learned labours in their native language once more revived learning and good taste in Europe. These, with some other critics of less celebrity, but equal utility, will unfold all the treasures of Grecian erudition, without however disclosing the source from which they flowed. To the above authors may be added a few celebrated moderns, such as M. Fourmont the Elder, M. Gebelin, Abbé Pezron, Salmasius, and especially the learned and industrious Lord Monboddo.

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nians had sent a colony into Egypt in the reign of Psammetichus; and a Greek settlement had been formed in Cyrenia many ages before. The Phocians had built Massilia or Marseilles as early as the reign of Cyrus the Great, where some remains of the Greek language are still to be discovered. Cæsar tells us, that in the camp of Helvetii registers were found in Greek letters. Perhaps no language ever had so extensive a diffusion, where it was not propagated by the law of conquest.

spo-
pre-

The Greek tongue, at this day, is confined within very narrow limits. It is spoken in Greece itself, except in Epirus or Albania, and the western parts of Macedonia. It is likewise spoken in the Grecian and Asiatic islands, in Candia or Crete, in some parts of the coast of Asia Minor, and in Cyprus; but in all these regions, it is much corrupted and degenerated. As a specimen, we shall insert a modern Greek song, and the advertisement of a quack medicine, which, with other plunder, was brought by the Russians from Chocsim or Chotzim in 1772.

ΜΙ δυσικίαις πολεμῶ μί βάσανα ὡς τὸ λεμό
  Εἶμαι καὶ κεντινεύω, καὶ νὰ χαθω κοντεύω
Στὸ πέλαγος των συμφυρῶν με ἐπίκινδυνον καιρὸν
  Μ' ανέμȣς ὀλάθριȣς σφοδρȣς και εναντιȣς.
Με κύματα πολλῶν καὶ μῶν τȣφανὶ άναϛενασμῶν.
  Θαλασσα φȣοκομένη, πόλλα ἀγριομένη,
῎Οπȣ ἀφρίζι καί φησὰ γε σαγανάκια περισσά
  Σύνεφα σκοτισμένα καὶ κατασυγχισμένα,
Και νὰ φανῆ μιὰ σωτηρία, νὰ ιδȣν τά μάτιά μȣϛεριὰ.
  Γλίχα νερά νὰ εὔρω, κάσχα καί δεν ἠξεύρῶ.
Ν' ἀραξω και δεν ἠμπορῶ γιατι λιμένα δεν θορῶ.
  Μ' ἀτελπισίαν θρέχω οτα ἄρμενα πȣ ἐχω.
Πȣ μὲ αὐτὰ κἀν νὰ πνυγῶ ἤ σελαμέτινα εὐγῶ,
  Καὶ τȣτα ἄν βαϛαξȣν, ἐμπορȣν νὰ μὲ φυλαξȣν.

  With dire misfortunes, pains, and woes,
O'erwhelm'd, ingulph'd, I struggling fight;
  O'er my frail bark proud billows close,
To plunge her deep in lasting night.
  Rough seas of ills incessant roar,
Fierce winds adverse, with howling blast,
  Heave surge on surge. Ah, far from shore
My found'ring skiff shall sink at last.
  Involv'd in low'ring darksome clouds,
'Mid sultry fogs, I pant for breath;
  Huge foaming billows rend my shrouds,
While yawning gulfs extend beneath.
  From bursting clouds loud thunders roll,
And deaf'ning peals terrific spread;
  Red lightnings dart from pole to pole,
And burst o'er my devoted head.
  When shall the friendly dawning rays
Guide me to pleasures once possest;
  And breezy gales, o'er peaceful seas,
Waft to some port of endless rest?
  In dark despair, with tempests tost,
I veer my sail from side to side.
  Conduct me, Heav'n! to yon fair coast,
  Or plunge me in the 'whelming tide.

ΒΑΛΣΑΜΟΝ ΤΗΣ ῾ΙΕΡΟΥΣΑΛΗΜ, ΑΠΟ ΤΑΙΣ, ΚΑΙ ΝΟΥΡΙΑΙΣ, ΚΑΙ ΠΑΛΕΑΙΣ ΡΕΤΖΕΤΑΙΣ.

ΤΟΥΤΟ τὸ μπαλσαμον ὠφελεῖ εις τὸ ἀδυνατόν ϛομαχι, καὶ βοηθεῖ τὴν χονευσιν δυναμώνει τὴν καρδίαν. συκώνει ὄλας τὰς ἐμφράξεις τῆς κοιλιας ωφελεῖ εἰς τὴν ϛενωσιν καὶ βῆχα παλαιὸν. ῾Ιατρέυεί τὰς ἐσωτερικὰς πληγὰς τȣ ϛήθȣς, καὶ τȣ πνεύμονος ἤγουν πλεμονίȣ. κινεῖ τα καταμήνια τῶν γυναικῶν. ᾿Εις τὰς ἐξωτερικὰς πληγὰς πρέπει νὰ βάζεται μὲ τὸ ξανθὸ πόσον ἐις παλαιὰς. Οσον καὶ ἐιονεας, καθὼς εἶναι ἡ οπαθιᾶις, καὶ μαχαιριαῖς, καὶ ἀλλα κοψίματα ἰατρευει κάθελογῆς Φιϛολα, καὶ ὀλας τὰς βρομερὰς πληγὰς ὁπȣ ἔφθασαν ἐις τὸ κὄκαλον θαυμάσιως, ὠφελεῖ εἰς τὰ ἀυτία ὁπȣ τρέχουν ἔμπυον νά ϛαζεται δὺο ἢ τρεῖς κόμπȣς ἤχουν ϛαλαγματίας μεϐαμπάκι βρεμμένον εἰς ἀυτὸ, βάνεται εἰς τὰς πληγωμενας δοντοκοιλιαῖς καὶ θέλουν ʽατρευθῆ. καὶ ἀκόμι δυναμώνει τὰ ὀδόντια ὁπȣ κινοῦν ται δε θελουν νὰ πέσουν· βοηθᾶ καὶ ἀπὸ τὴν πανȣκλαν.

῾Η δόσις ἐσωτερικῶς ἂς εἶναι δεκα ἢ καὶ δώδεκα κόμπȣς εἰς ὀλίγον κρασὶ, ἢ καὶ νερον, τὸ κάθε ταχυ καὶ βράδυ. ἂς τὸ μεταχειρίζεται, κὰι εἶνα θαυμάσιον μὲτὴν δοκιμὴν βεϐαιωμενον.

᾿Αληθὲς βάλσαμον τȣ Βασιλειȣ.

Instead of giving a literal and bald translation of this advertisement, which runs exactly in the style of other quack bills, it may be sufficient to observe, that the medicine recommended is said, when taken inwardly, to raise the spirits, remove costiveness and inveterate coughs; to cure pains of the breast and stomach-aches; to assist respiration, and remove certain female obstructions. When applied externally, it cures wounds and sores, whether old or fresh, removes ringing of the ears, fastens the teeth when loose, and strengthens the gums. All this, and much more, it is said to do in a wonderful manner; and is declared to be the true royal balsam of Jerusalem, and an universal specific.

It is indeed next to a miracle that so many monuments of Grecian literature are still to be found amongst men. Notwithstanding the burning of the famous library of Alexandria, and the almost numberless wars, massacres, and devastations, which have from time to time in a manner desolated those countries where the Greek once flourished; we are told that there still remain about three thousand books written in that language.

Stages of the Greek language.

We shall now conclude this section with a brief detail of the most distinguished stages and variations through which this noble tongue passed from the age of Homer till the taking of Constantinople, in the year 1453, a period of more than two thousand years.

Homer gave the Greek poetry its colour and consistency, and enriched, as well as harmonized, the language. From the coincidence of epithets and cadence in Homer and Hesiod, it appears that the Greek heroic verse was formed spontaneously, by the old Αοιδοι, a sort of *improvisatori;* and that Homer and his early followers adopted their versification. The Iliad and Odyssey have much of the air of extempore compositions; an epithet is never wanting to fill up a verse; and a set of expressions are mechanically annexed to such ideas as were of frequent recurrence. Hence that copiousness and profusion of words in the old Greek bard, which forms such a contrast to the condensed and laboured composition of Virgil.

The Greek prose was of a more difficult structure; and it may be distributed into different styles or degrees of purity. Of the prose authors now extant, the first and best style is that of Herodotus in the natural, and of Plato in the florid or mixed kind, of Xenophon in the pure and simple, of Thucydides and Demosthenes in the austere style. Nothing, perhaps, is so conducive to form a good taste in composition as the study of these writers.

The style of Polybius forms a new epoch in the history of the Greek language. It was the idiotic or popular manner of expression, especially amongst military men, in his time, that is, about the 150th Olympiad. It became the model of succeeding writers, by introducing a simple unstudied expression, and by emancipating them from the anxious labour of the old Greeks respecting the cadence and choice of words. The style of the New Testament, being plain and popular, frequently resembles that of Polybius, as has been fully shown by Raphelius, and by Kirchmaier.[1]

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[1] *De Parallelismo Novi Testamenti et Polybii*, 1725.

Before this historian, the Alexandrian Jews had formed a new or Hellenistic style, resulting from the expression of oriental ideas and idioms in Greek words, after that language had lost of its purity, in proportion as it gained in general use, by the conquests of Alexander. The Hellenistic is the language of the Septuagint, the Apocrypha, the New Testament, and partly of Philo and Josephus. This mixture in the style of the evangelists and apostles, is one credential of the authenticity of the best of all books, a book which could not have been written except by Jewish authors in the first century.[1] Critics lose their labour in attempting to adjust the Scripture-Greek to the standard of Atticism.

The diction of the Greek historians, and geographers of the Augustan age, is formed on that of Polybius, but improved and modernized, like the English of the present age, as compared with that of Clarendon or Bacon. More perspicuous than refined, it was well suited to such compilations as were then written by men of letters, such as Dionysius, Diodorus, and Strabo, without much experience or any eminent rank in public life.

The ecclesiastical style was cultivated in the Christian schools of Alexandria, Antioch, and Constantinople; it was rank and luxuriant, full of oriental idioms, and formed in a great measure on the Septuagint version. Such for instance, is the style of Eusebius. After him, the best Christian writers polished their compositions in the schools of rhetoric under the later sophists. Hence the popular and flowing purity of St. Chrysostom, who has more good sense than Plato, and perhaps as many good words.

On the Greek of the Byzantine empire, there is an excellent dissertation by Ducange, *de Causis corruptæ Græcitatis*, prefixed to his glossary, together with Portius's Grammar of the modern Greek. This last stage of the Greek language presents a miserable picture of Turkish barbarism; and, what is most surprising, there is no city of Greece where the language is more different from the ancient than at Athens; the reason of which seems to be, that that city has long been inhabited by a mixed multitude of different nations.

In a word, the Greeks have left the most durable monuments of human wisdom, fortitude, magnificence, and ingenuity, in their improvement of every art and science, and in the finest writings upon every subject necessary, profitable, elegant, or entertaining. They have furnished the brightest examples of every virtue and accomplishment, natural or acquired, political, moral, or military. They excelled in mathematics and philosophy; in all the forms of government, in architecture, navigation, commerce, war; as orators, poets, and historians, they stand yet unrivalled, and are likely to remain so for ever; nor are they less to be admired for the exercises and amusements they invented, and brought to perfection, in the institution of their public games, their theatres, and sports.

No perfect translation of any Greek author.

Let us further observe, that in vain will our readers look for these admired excellencies in any of the best translations from the Greek; they may indeed communicate some knowledge of what the originals contain; they may present the reader with propositions, characters, and events; but allowing them to be more faithful and more accurate than they really are, or can well be, still they are no better than copies, in which the spirit and lustre of the originals are almost totally lost. The mind may be instructed, but will not be enchanted; the picture may bear some faint resemblance, and if painted by a masterly hand may give pleasure; but who would be satisfied with the canvass, when he may possess the real object? who would prefer a piece of coloured glass to a diamond? It is not possible to preserve the beauties of the original in a translation. The powers of the Greek vastly exceed those of any other tongue. Whatever the Greeks describe is always felt, and almost seen; motion and music are in every tone, enthusiasm and enchantment possess the mind.

> Graiis ingenium, Graiis dedit ore rotundo,
> Musa loqui.

SECT. VIII. OF THE LATIN LANGUAGE.

Origin o the Ro- mans, an of their languag

This language, like every other spoken by barbarians, was in its beginning rough and uncultivated. What people the Romans were, is a point as to which antiquarians are not yet agreed. In their own opinion they were sprung from the Trojans;[2] Dionysius of Halicarnassus derives them from the Greeks;[3] and Plutarch informs us[4] that some people imagined they were sprung from the Pelasgians. The fact is, they were a mixture of people collected out of Latium and the adjacent parts, whom a variety of accidents had induced or compelled to establish themselves in that mountainous region, in order to secure their own property, and plunder that of their neighbours. They were in all probability composed of Arcadians, Sabines, Latins, Hetruscans, Umbrians, Oscans, Pelasgians, and others; and if so, their language must have been a mixture of the different dialects peculiar to all these discordant tribes.

The Latin language ought then to be a commingled mass of the Arcadian, that is, the Æolian Greek,[5] the Pelasgic, Hetruscan, and Celtic dialects. But these jarring elements, like the people to whom they respectively belonged, gradually incorporated, and produced what was afterwards called the Latin tongue.

The Arcadians were a Pelasgian tribe,[6] and consequently spoke a dialect of that ancient Greek produced by the coalition of this tribe with the savage aborigines of Greece. This dialect was the ground-work of the Latin. Every scholar allows, that the Æolian Greek, which was strongly tinctured with the Pelasgic, constituted the model upon which the Latin language was formed. From this deduction it appears, that the Latin tongue is much more ancient than the modern Greek; and of course we may add, that the Greek, as it stood before it was thoroughly polished, bore a very near resemblance to that language. Hence it may be concluded, that the knowledge of the Latin language is necessary in order to understand the Greek. Let us not then expect to find the real ingredients of the Greek tongue in the academic groves of Athens, or in Smyrna, or in Rhodope, or in Hæmus; but let us seek for them on the banks of the Tiber, and on the fields of Laurentum.

A very considerable part of the Latin tongue was derived from the Hetruscan. That people were the masters of the Romans in every thing sacred. From them they learned the ceremonies of religion, the method of arranging games and public festivals, the art of divination, the interpretation of omens, the method of lustrations, expiations, &c. It would, we believe, be easy to prove, that the Pelasgians[7] and Hetruscans[8] were the same race of people; and if this was the case, their languages must have differed in dialect only.

The Umbrian or the Celtic enters deeply into the composition of the Latin tongue. In proof of this, we need only refer to Pelloutier, Bullet's *Mémoires de la Langue Celtic partie première*, Abbé Pezron's *Origin of Ancient Nations*, and other works of a similar kind. Whether the old Celtic differed essentially from the Pelasgic and Hetruscan, would be a matter of curious investigation, were this a proper subject for the present article.

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[1] See the fine remarks of Bishop Warburton, *Doctrine of Grace*, book i. ch. 8—10.

[2] Titus Livius, lib. i. cap. 1, &c.

[3] *Antiq. Rom.* lib. i.

[4] *Vita Romul.*

[5] Strabo, lib. v. Dionysius Halicarnasseus, *Antiq.* lib. i.

[6] Strabo et Herodotus.

[7] Thucydides, lib. vi.

[8] The Hetrusci were variously denominated by the Greeks and Romans. The former called them Τυϱσηνοι, which was their true name, for they actually emigrated from Tarshish, or the western coast of Asia Minor, and consequently Herodotus everywhere calls them Τυϱσηνοι. The Æolians changed α into υ; hence in that dialect they were called Τυρσηνοι, from *Tarsus*. The Romans styled them *Tusci*, probably from the Greek verb ϑυω, *sacrifico*, alluding to the skill which that people professed in the ceremonies of religion. They called their country *Hetruria*, we think from the Chaldaic word *heretum*, a magician or sorcerer; a name deduced from their skill in divination.

The Latin abounds with oriental words, especially Hebrew, Chaldaic, and Persian. These are certainly remains of the Pelasgian and Hetruscan tongues, spoken originally by people who emigrated from regions where such words formed parts of the vernacular language. The Greeks, in polishing their language, gradually distorted and disfigured vast numbers of the rough eastern terms, which formed a very great part of it, as we have already shown in the preceding section.

The Romans, of less delicate organs, left them in their natural state, and their natural air readily betrays their original. We had collected a large list of Latin words still current in the East; but we find that Thomassin[1] and Ogerius,[2] and especially M. Gebelin, in his excellent Latin Dictionary, have rendered that labour superfluous.

In this language, too, there are not a few Gothic terms. How these found their way into the Latin, it is not easy to discover, unless, as Pelloutier supposes, the Celtic and Gothic languages were originally the same; or perhaps it may be conjectured, that such words formed part of a primitive language, which was at one time universal.

ow far e Latin embles e Greek.

There are, besides, in the Latin a great number of obsolete Greek words, which were in process of time obliterated, and others substituted in their stead; so that, upon the whole, we are persuaded, that the most effectual method for distinguishing the difference between the early and modern Greek, would be to compare the ancient Latin with the more recent, especially as there existed very little difference between the ancient Greek and Latin in the earliest periods. But however this may be, it is certain that the Roman letters were the same with the ancient Greek. *Formæ literis Latinis quæ veterrimis Græcorum*, says Tacitus,[3] whilst Pliny[4] states the same thing, and for the truth of his assertion appeals to a monument extant in his own time. These old Greek letters were no other than the Pelasgian, which we have shown from Diodorus Siculus to have been prior to the Cadmean.[5]

That the Latins borrowed the scheme of their declensions from the Greeks, is evident from the exact resemblance of the terminations of the cases throughout the three similar declensions. In nouns of the first declension, the resemblance is too palpable to stand in need of illustration. In the second, the Greek genitive is οι; but in Latin the *o* is thrown out, and the termination becomes *i*. In the section on the Greek language, we have observed, that the sounds of ι and υ differed very little; therefore the Latins used ι instead of υ. The Latin dative ends in *o*, which is the Greek dative, throwing away ι *subscriptum*, which was but faintly sounded in that language. No genuine Greek word ended in μ or *m*. The Hellenes seem to have abhorred that bellowing liquid; it is certain, however, that they imported it from the East, as well as the other letters, and that they employed it in every other capacity, except in that of closing words. In the termination of flexions, they changed into υ. The Latins retained *m*, which had been imported to them as a terminating letter at an era before the Greek language had undergone its last refinement. Hence the Latin accusative in *um*, instead of the Greek in ον. The vocative case, we imagine, was in this declension originally like the nominative. The Latins have no dual number, because, in our opinion, the Æolic dialect, from which they copied, had none. It would no doubt, be a violent stretch of etymological exertion, to derive either the Latin genitive plural of the second declension from the same case of the Greek, or that of the latter from the former; we therefore leave this anomaly, without pretending to account for its original formation. The third declensions in both languages are so exactly parallel, that it would be superfluous to compare them. But even here the dative plural is another anomaly, and we think a very disagreeable one, which we leave to the conjectures of more profound etymologists. For the other peculiarities of Latin nouns, as they are nearly similar to those of the Greek, we must beg leave to refer our readers to that section.

Deficiency of articles.

The Latins have no articles, which is certainly a defect in their language. The Pelasgic, from which they copied, had not adopted that word in the demonstrative sense. Homer indeed seldom uses it; and the probability is, that the more early Greeks used it less frequently, at least in the sense above mentioned. Thus in Latin, when I say, *video hominem*, it is impossible to find out by the bare words whether the word *hominem* intimates a man, or the man, whereas in Greek it would be βλεπω ἀνθρωπον, *I see a man*, βλεπω τον ανθρωπον, *I see the man*. Hence the first expression is indefinite, and the second definite.

Origin of the substantive and of other verbs.

The substantive verb *sum* in Latin seems to be formed partly from the Greek and partly not. Some of the persons of the present tense have a near resemblance to the Greek verb ἐω or ἐιμι, whilst others vary widely from that archetype. The imperfect præterite and præterperfect have nothing in common with the Greek verb, and cannot, we think, be forced into an alliance with it. The future *ero*, was of old *eso*, and is indeed genuine Greek. Upon the whole, in our apprehension, the Latin substantive verb more nearly resembles the Persian verb *hesten* than that of any other language with which we are acquainted.

From what exemplar the Latin verbs were derived, it is by no means easy to ascertain. We know that attempts have been made to deduce them all from the Æolic Greek, and that the Romans themselves were extremely fond of this chimera; but the almost numberless irregularities, both in the formation and conjugation of their verbs, induce us to believe that only a part of them were formed upon that model. We are inclined to think that the terminations in *bam, bas, bat, bamus*, &c. were produced by their union with a fragment of some obsolete verb, which is now wholly lost. In the verb *amo*, for instance we are sure that the radix *am* is the Hebrew word *mother;* but how *am-abam, am-abo, am-arem* were fabricated, and connected with the radical *am*, is not so easily determined. That Latin verbs, as well as the Greek, are composed of an inflexible radix and another flexible verb, cannot be doubted; but what this flexible auxiliary was, cannot now be clearly ascertained. It is not altogether improbable that such parts of the verbs as deviate from the Greek archetype were supplied by fragments of the verb *ha*, which pervades all the branches of the Gothic language, and has, we conceive produced the Latin verb *habeo*. When the Greeks began to etymologise, they seldom overpassed the verge of their own language; and the Latins pursued nearly the same course. If their own language presented a plausible etymology, they embraced it; if not, they immediately had recourse to the Greek; and this was the *ne plus ultra* of their etymological researches. Cicero, Quintillian, Festus, and even Varro, the most learned of all the Romans, stop here; all beyond is either doubt or impenetrable darkness. Their opinion above mentioned we offer only as a conjecture; as to the decision we leave it to more able critics.

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[1] Glossary.

[2] *Græca et Latina lingua Hebraizantes*, Venice 1763. If these books are not at hand, Dr. Littleton's Dictionary will, in a great measure, supply their place.

[3] Tacitus, *Anal.* lib. i.

[4] *Nat. Hist.* lib. vii. cap. 58.

[5] For the figure of these letters, see Astle, Postellus, Montfaucon, *(Palægraphia Græca,)* M. Gebelin, and others.

Deficiencies in Latin verbs.

The want of aorists or indefinite tenses seems to us to be a palpable defect in the Latin language. The use of these amongst the Greeks entitled the writer to express the specific variations of time with more accuracy and precision than the Latins, who never attempted to specify them by any other tenses but the imperfect and pluperfect. Indeed we should imagine, that both the Greeks and Latins were much inferior to the English in this respect. The Latin word *lego*, for example, may be translated into English three different ways; as, *I read, I do read*, and *I am reading*.

Irregularities in the conjugations.

The Latins, in reducing their verbs to four conjugations, formed their inflexions in a very irregular manner. Numbers of the first class inflect their præterite and supine like those of the second; thus, *domo*, instead of giving *avi* and *atum*, has *ui* and *itum*, like *monui* and *monitum*. Again, not a few verbs of the third conjugation have *ivi* and *itum*, as if they belonged to the fourth; e. g. *peto, petivi, petitum*. Then, some verbs have *io* in the present, *ivi* in the præterite, and *itum* in the supine, whilst, contrary to the rules of analogy, they in reality belong to the third; such are *cupio, cupivi, cupitum, cupere*, and others. Some verbs of the second conjugation have their præterite and supine as if they belonged to the third; thus, *jubeo, jussi, jussum, jubere*, and *augeo, auxi, auctum, augere*. Some verbs, which are actually of the fourth conjugation, have their præterite and supine as if they were of the third; thus, *sentio, sensi, sensum, sentire*, and *haurio, hausi, haustum, haurire*. If these are not manifest irregularities, we cannot say what deserves the name. The fact seems to stand thus. The Romans were originally a banditti of robbers, bankrupts, runaway slaves, shepherds, husbandmen, and peasants of the most unpolished character. They were engaged in perpetual broils and quarrels at home, and seldom enjoyed repose abroad. Their profession was robbery and plunder. Like old Ishmael, their hands were against every man, and every man's hand was against them. In such a state of society no time was left for cultivating the sciences. Accordingly, the arts of war and government were their sole profession. This is so true, that their own poet has characterized them in the following manner:—

> Excudent alii spirantia mollius aera,
> Credo equidem: vivos ducent de marmore vultus;
> Orabunt causas melius; coelique meatus
> Describent radio, et surgentia sidera dicent:
> Tu regere imperio populos, Romane, memento:
> Hae tibi erunt artes: pacisque imponere morem,
> Parcere subjectis, et debellare superbos.

The Latin deficient in participles.

Another blemish in the Latin language is occasioned by its wanting a participle of the præterite sense in the active voice. This defect is perpetually felt, and is the cause of an awkward circumlocution wherever it happens to present itself. Thus, *Imperator, cum transiiset flumen, aciem instruxit;* the general having crossed the river drew up his army. Here *cum transiiset flumen* is a manifest circumlocution, which is at once avoided in the Greek ὁ ἡγεμων περασας τον ποταμον, κ. τ. λ. This must always prove an incumbrance in the case of active intransitive verbs. But when active deponent verbs occur, it is easily avoided. Thus, *Cæsar cohortatus milites, prælii committendi signum dedit;* Cæsar having encouraged the soldiers, gave the signal for joining battle. Another palpable defect in this language arises from the want of a participle of the present passive. This again must be productive of inconvenience upon many occasions, as will be obvious to every Latin student.

Supines and gerunds.

The two supines are universally allowed to be substantive nouns of the fourth declension. How these assumed the nature of verbs it is not easy to determine. When they are placed after verbs or nouns, the matter is attended with no difficulty; but how they should acquire an active signification, and take the case of the verb with which they are connected, is not so easily accounted for, and certainly implies a stretch of prerogative. The Latin gerunds form another unnatural anomaly. Every scholar knows that these words are nothing but the neuters of the participles in *dus* of the future passive. The fabricators of the Latin language, however, elevated them from their primary condition, giving them upon many occasions an active signification. In this case we must have recourse to the

> Si volet usus,
> Quem penes arbitrium est, et jus et norma loquendi.

Another inconvenience, which is perhaps more severely felt than any of the preceding, arises from the want of the use of the present participle of the verb *sum*. Every body knows what a convenience is derived from the frequent use of the participle ὢν in Greek; and indeed it appears to us somewhat surprising that the Latins neglected to introduce the participle *ens* into their language. In this we believe they were singular. Here again a circumlocution becomes necessary. In such a case as the following, "The senate being at Rome, passed a decree," instead of saying *senatus ens Romæ, legem tulit*, we are obliged to say *cum senatus Romæ esset, legem tulit*. If the words *ens* or *existens* had been adopted, as in the Greek, this odious circumlocution would have been avoided. Many other defects of a similar kind will occur to every person who shall choose to search for them, and these, too, in the most approved classical authors.

Different genius of the Latin and Greek languages.

If any one will take the trouble to compare the structure of the Greek and the Latin languages, he may very soon be convinced that their characteristic features are extremely different. The genius of the former appears easy and natural; whereas that of the latter, notwithstanding the united efforts of the poets, orators, and philosophers, who wrote in it, still bears the marks of violence and restraint. Hence it appears that the Latin language was pressed into the service, and compelled almost against its peculiar genius to bend to the laws of the Grecian model. Take a sentence of Hebrew, Chaldaic, Arabian, or Persian, and try to translate it into Greek without regarding the arrangement of the words, and you will find it no difficult task; but make the same trial with respect to the Latin, and you will probably discover that the attempt is attended with considerable difficulty. To translate Greek into English is not a laborious task; the texture of the two languages is so congenial, that the words and phrases, and even the idiomatic expressions, naturally slide into each other. But with the Latin the case is quite otherwise; and before elegant English can be produced, one must deviate considerably from the original. Should we attempt to translate a piece of English into Greek, and at the same time into Latin, the translation of the former would be attended with much less difficulty than that of the latter, supposing the translator to be equally skilled in both languages.

Causes of this differ ence.

This incongruity seems to spring from the following cause. Before any man of considerable abilities, either in the capacity of a poet, grammarian, or rhetorician, appeared at Rome, the language had acquired a strong and inflexible tone, too stubborn to be exactly moulded according to the Grecian standard. After a language has continued several centuries without receiving a new polish, it becomes like a full grown tree, incapable of being bent to the purposes of the mechanic. For this reason, it is highly probable, that the language in question could not be forced into a complete assimilation with the Greek. But notwithstanding all these obstructions, in process of time it arrived at such an exalted pitch of perfection, as to rival, perhaps to excel, all the other European languages, Greek only excepted. Had men possessing the taste, judgment, and industry of Ennius, Plautus, Terence, Cicero, and the worthies of the Augustan age, appeared in the early stages of the Roman commonwealth, their language would have been thoroughly reduced to the anguage.

Grecian archetype, and the two dialects might have improved each other by a rivalship between the nations who employed them.

Without pretending to encumber our readers with a pompous and elaborate account of the beauties of that imperial language, which have been detailed by writers almost without number, we shall endeavour to lay before them as briefly as possible its pristine character, the steps by which it gradually rose to perfection, the period when it arrived at the summit of its excellence, and the means by which it rapidly degenerated until it was finally lost amongst the very people to whom it had owed its birth.

he Latin mposed iefly of elasgic d Celtic ords.

We have observed already, that the Latin was originally a *colluvies* of all the languages spoken by the vagrant people who composed the first elements of that republic. The prevailing dialects were the Pelasgian or Etruscan, which we conceive to have been the same; and the Celtic, which was undoubtedly the aboriginal idiom of Italy. Hence the primary dialect of the Romans was composed of discordant materials, which in our opinion never acquired a natural and congenial union. The Pelasgian or Etruscan part of it retained a strong tincture of the oriental style. But the Celtic portion appears to have been the prevalent one, since we find that most of the names of places, especially in the middle and northern parts of Italy, are actually of Celtic origin.[1] It is clear therefore that the dialect of the first Romans was composed of the languages above mentioned. Who those first Romans were, it is impossible to determine with any degree of certainty; indeed the Roman historians afford us as little information upon the subject, as their etymologists do respecting the origin of their language. Their most celebrated writers upon this point were Ælius Gallus, Quintus Cornificius, Nonius Marcellus, Festus, and some others of less note. At the head of these we ought to place Terentius Varro, whom Cicero styles the most learned of all the Romans. But from such writers we need expect no light. Their etymologies are generally childish and futile. Of the language of the most ancient Romans we can only reason by analogy; and by that rule we can discover nothing more than what has already been advanced.

We may rest assured that the dual number, the articles, the participle above mentioned, the aorists, and the whole middle voice, never appeared in the Latin language; and for this reason that they were not current in those languages from which it was derived, at least at the time when it was first fabricated. Besides all this, many circumstances concur to make it highly probable that, in the earliest period of the language, very few inflexions were introduced. First, when the Pelasgians left Greece, the Greek language itself was not fully polished. Secondly, the Arcadians were never thoroughly civilized. They were a rustic pastoral people, and minded little the refinements of a civilized state; consequently the language which they brought into Italy at that era must have been of a coarse and irregular contexture. Thirdly, when the Thessalian Pelasgians arrived in Italy about the time of Deucalion, the Greek language itself was rude and barbarous;[2] and, which is of still more consequence, if we may credit Herodotus quoted in the former section, the Greek people had never adopted the Hellenic tongue. Hence it appears, that the part of the Latin language derived from the Pelasgian or Etruscan must have taken a deep tincture from the oriental tongue. If we may judge of the Celtic of that age by the Celtic of the present, the same character must likewise have distinguished its structure.

iginally le in- cted.

Latin Language.

From these circumstances, we think it appears that the earliest language of the Romans was but very little diversified by means of inflections. It nearly resembled the oriental exemplar, and consequently differed widely from the modern Latin. The effect of this was, that the modern Romans could not understand the language of their early progenitors. Polybius,[3] speaking of the earliest treaty between the Romans and Carthaginians, makes the following observation: "Believe me," says he, "the Roman language has undergone so many changes since that time to the present, that even those who are most deeply skilled in the science of antiquities cannot understand the words of that treaty except with the greatest difficulty."[4] From this source, then, has flowed that great number of oriental words with which the Latin language is impregnated. Being originally inflexible, they were not disguised as they now are with prefixes, affixes, metatheses, syncopes, antitheses, and the like, but plain and unadorned in their natural dress.

Afterwards formed on the Greek model.

After the Romans had become acquainted with the Æolian Greeks, who gradually seized upon both coasts of Italy towards the south, which they called Magna Græcia, they began to affect a Grecian air, and to torture their language into a foreign contexture. It appears, however, that at first the Grecian attire had rather an awkward appearance, and that several marks of violence were easily discerned. The most ancient specimen of this kind that we can recollect consists of the remains of the Twelve Tables. Here every thing is rude and of a clumsy cast; for although by this time considerable progress had been made in refinement, and the language of Rome had begun to appear in a Grecian uniform, still those changes were not altogether natural. Soon afterwards appeared Marcus Fabius Pictor and Sisenna, historians often quoted by Livy, but whose works have long since been irrecoverably lost. The Fasti Capitolini are frequently mentioned; but they too perished in the burning of the Capitol during the civil wars between Marius and Sylla. If those monuments had escaped the ravages of time, we should have been able to mark the progress of the Latin language from stage to stage, and to ascertain with the greatest accuracy its gradual configuration in the course of its progress towards the Grecian standard. We must therefore abandon the attempt to trace the Latin during those rude and barbarous periods, and descend to others which are better known and more characteristically marked. The latter, commenced when

> Græcia capta ferum victorem cepit, et artes
> Intulit agresti Latio.

The authors by whom it was polished.

In this period flourished Ennius, who wrote in eighteen books, a Roman history in hexameter verse, which he called *Annals*, the greater part of which is now unhappily lost. He likewise translated Euhemerus *de Origine Deorum*, a work often mentioned by the Christian fathers in their disputes with the Pagans, and which is sometimes quoted by Cicero. Then followed Caius Lucilius the famous satirist, and a number of other writers, such as Accius, Valerius, Ædituus, Alpinus, whose fragments were published by the Stephens, at Paris, in 1564. All these imitated the writers of Greece or translated from them. By their perseverance and active exertions, the spirit of the Greek authors was transfused into the Latin language, and its structure accommodated to the Grecian standard.

Plautus and Terence, by translating into their own language, the comedies of Menander and Diphilus taught the Latin muses to breathe their inspirations in Attic Greek. To speak that language was then the fashion of the times, as it is now with us to chatter French. Greek tutors were retained in every reputable family; and many Romans of the first rank were equally qualified to speak or write both in Greek and in Latin. The original jargon of Latium had now become obsolete and unintelligible; and even Cato the Ancient condescended to learn the Greek language at the age of eighty.

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[1] For proof of this our readers may consult Abbé Pezron, Pelloutier, Bullet's *Mémoires*, Gebelin, *Præf. Dict. Lat.* and many others.

[2] Dionysius Halicarnasseus, lib. i.

[3] See his History, lib. iii. *sub initio.*

[4] This treaty, according to the same historian, was concluded in the consulship of Lucius Junius Brutus and Marcus Valerius, twenty-eight years before Xerxes made his descent upon Greece.

Golden age of Rome.

To pretend to enumerate the various, and we may add inimitable, examples of the Augustan or golden age of the Roman language, would be an insult to the understanding of our readers. We shall only take the liberty to translate a few lines from an able and excellent historian,[1] who, had his honesty been equal to his judgment, might have rivalled the most celebrated writers of his country. Having observed that the Greek authors, who excelled in every province of literature, had all made their appearance nearly about the same time, and within a very short space of one another, he adds: “Nor was this circumstance more conspicuous amongst the Greeks than amongst the Romans; for unless we go back to the rough and unpolished times, which deserve commendation only on account of their invention, the Roman tragedy is confined to Accius and the period when he flourished. The charming wit of Latin elegance was brought to light by Cecilius, Terentius, and Afranius, nearly in the same age. As for our historians if we except Cato and some old obscure writers, they were all confined to a period of about eighty years; so neither has our stock of poets extended to a great space either backwards, or forwards. But the energy of the bar, and the finished beauty of prose eloquence, setting aside the same Cato (by the leave of Crassus, Scipio, Lælius, the Gracchi, Fannius, and Ser. Galba, be it spoken), broke out all at once under Tully the prince of his profession; so that one can now be delighted with none before him, and admire none except such as have either seen that orator or been seen by him.”

Causes of the degeneracy of the Latin language.

From this quotation it evidently appears, that the Romans themselves were convinced of the short duration of the golden age of their language. According to the most judicious critics, it commenced with the era of Cicero's oratorical productions, and terminated with the reign of Tiberius, or rather, perhaps, it did not reach beyond the middle of that prince's reign. It is generally believed that eloquence, and with it every thing liberal, elevated, and manly, was banished from Rome by the despotism of the Cæsars. But we imagine that the transition was too instantaneous to have been entirely produced by that cause. Despotism was firmly established amongst the Romans about the middle of the reign of Augustus; and yet that period produced such a group of learned men as never perhaps adorned any other nation in so short a space of time. Despotism, we acknowledge, might have affected the eloquence of the bar, the noble and important objects which had animated the republican orators being now no more; but this circumstance could not affect poetry, history, philosophy, and jurisprudence. The style employed upon these subjects did not feel the fetters of despotism. The reign of Louis XIV. was the golden age of the French language; and we think that age produced a race of learned men, in every department superior in number and equal in genius to the literati who flourished under the noble and envied constitution of Britain during the same period, although the latter is likewise said to have been the golden age of this country. The British Islands, we conceive, still enjoy as much liberty as ever; yet we believe there are few persons who will affirm, that the writers of the present day are equal either in style or in genius to that noble group who flourished from the middle of the reign of Charles I. to the middle of the reign of George II.

In the East the same observation seems to hold true. The Persians have long groaned under the Mohammedan yoke; and yet every oriental scholar will allow, that in that country, and under the most galling tyranny, the most amazing productions of taste, genius, and industry, that ever dignified human nature, have been exhibited. Under the Arabian caliphs, the successors of Mohammed, appeared writers of a most sublime genius, although despotism was never more cruelly exercised than under those fanatics. The revival of letters in Italy during the fourteenth century, was chiefly promoted and cherished by the petty despots of that country. We cannot therefore be persuaded that the despotism of the Cæsars banished eloquence and learning from Rome. Longinus indeed has attributed this misfortune to the cause just stated, and tells us, that it is liberty which is formed to nurse the sentiments of great geniuses, to push forward the propensity of contest, to inspire them with the generous ambition of being the first in the first rank. But when Longinus wrote this, he did not reflect that he himself was a striking instance of the unsoundness of his own observation.

The writers of the silver age

As to science, the fact is undoubtedly on the other side. That Seneca was superior to Cicero in philosophy, cannot be reasonably contradicted. The latter had read, and actually abridged, the whole mass of Grecian philosophy; but this displayed his reading rather than his learning. The former had addicted himself to the Stoic sect; and though he does not write with the same flow of eloquence as Tully, he thinks more deeply and reasons more closely. Pliny's Natural History is indeed a wonderful collection, and contains more useful knowledge than all the writings of the Augustan age condensed into one mass. The historical annals of Tacitus, if inferior to Livy in elegance of style and majesty of diction, are much superior in arrangement and in vigour of composition. In short, we discover in these productions a deep insight into human nature, an extensive knowledge of the true science of government, a penetration which no dissimulation could escape, together with a sincere attachment to truth respecting both events and characters; nor is he inferior in the majesty, energy, and propriety of his harangues, wherever an equal opportunity presents itself. Quintilian, Pliny the younger, Suetonius, Petronius Arbiter, and Juvenal deserve high commendation, and are not inferior to their immediate predecessors. We think there is good reason to conclude, that the loss of liberty amongst the Romans did not produce the extinction of eloquence, science, elevation of sentiment, or refinement of taste. The circumstances which chiefly contributed to produce that revolution were of a different description.

Velleius Paterculus whom we have already quoted assigns some very plausible and judicious reasons for the catastrophe in question. “Emulation,” says he “is the nurse of genius; and one while envy, and another admiration fires imitation. According to the laws of nature, that which is pursued with the greatest ardour mounts to the top; but to be stationary in perfection is a difficult matter; and by the same analogy, that which cannot move forward must go backward. As at the outset we are animated to overtake those whom we deem before us, so when we despair of being able to overtake or to pass by them, our ardour languishes together with our hope; what it cannot overtake it ceases to pursue, and leaving the subject as already engrossed by another, it looks out for some new one upon which to exert itself. That by which we find that we are not able to acquire eminence we speedily relinquish, and try to discover some object elsewhere upon which to employ our intellectual powers. The consequence is, that frequent and variable transitions from subject to subject prove a great obstacle to the attainment of perfection in any profession.”

This was perhaps the case with the Romans. The heroes of the Augustan age had borne away the prize of eloquence, history, poetry, and elegant literature; and their successors despaired of being able to equal, much less to surpass them, in any of these pursuits. They were therefore placed under the necessity of striking out a new path by which they might hope to arrive at eminence. Consequently Seneca introduced the *stile coupé*, as the French call it; that is, a short, sparkling, figurative diction, abounding with antitheses, quaintnesses, witticisms, and embellished with meretricious ornaments; whereas the style of the Augustan age was natural, simple, solid, unaffected, and properly adapted to the nature of the subject as well as to the sentiments of the author.

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[1] Velleius Paterculus, lib. i cap. *ult.*

The historian Sallust laid the foundation of the unnatural style here mentioned. Notwithstanding all the excellencies of that celebrated author, he everywhere exhibits an affectation of antiquity, an antithetical cast, an air of austerity, an accuracy, exactness, and regularity, the very opposite of that *air degagé* which nature displays in her most finished efforts. His words and his clauses seem to be adjusted exactly according to number, weight, and measure, without either excess or defect. Valleius Paterculus imitated this writer; and, as is generally the case with imitators, succeeded best in those points where his archetype had failed most egregiously. Tacitus, however excellent in other respects, deviated from the Augustan exemplars, and is thought to have imitated Sallust; but affecting brevity to excess, he often falls into obscurity. The other contemporary writers employ a cognate style; and because they have deviated from the Augustan standard, their works are held in less estimation, and are thought to bear about them marks of degeneracy. This degeneracy, however, did not spring from the despotic government under which these authors lived, but from the affectation of singularity into which they were betrayed by an eager though fruitless desire of signalizing themselves in the new mode, as their predecessors had done in the old.

But the mischiefs of this rage for innovation did not reach their sentiments, as it had done their style; for in that point we think they were so far from falling below the measure of the writers of the former age, that in many instances they appear to have surpassed them. With respect to sentiment and mental exertions, the authors in question preserved their vigour, till luxury and effeminacy, the consequence of power and opulence, enervated both the bodies and the minds of the Romans. The contagion soon became universal; and a listlessness, or intellectual torpor, the usual concomitant of luxury, spread an indolence over the mental faculties, which rendered them not only averse to, but even incapable of, industry and perseverance. This lethargic disposition of mind seems to have commenced towards the conclusion of the silver age; that is, about the end of the reign of Hadrian. It was then that the Roman eagle began to stoop, and that, in arts as well as in arms, the genius of Rome showed symptoms of decline.

As the Roman genius began, about this period, to decline, so the style of the silver age became gradually vitiated with barbarisms and exotic forms of speech. The multitudes of barbarians who flocked to Rome from all parts of the empire; the ambassadors of foreign princes, and often the princes themselves, with their attendants; the prodigious numbers of slaves who were entertained in all the considerable families of the capital, and throughout Italy; the frequent commerce which the Roman armies upon the frontiers carried on with the barbarians; all concurred to vitiate the Latin language, and to interlard it with foreign words and idioms. In such circumstances, it was impossible for that or any other form of speech to continue pure and untainted. But this vitiated character both of style and of sentiment became more and more prevalent, in proportion as it descended from the reign of Hadrian towards the era of the removal of the seat of empire from Rome to Constantinople. Then succeeded the iron age, when the Roman language became absolutely rude and barbarous.

Writers during the silver and brazen ages.

Towards the close of the silver, however, and during the whole course of what is called the brazen age, there appeared many writers of no contemptible talents. The most remarkable was Seneca the stoic, the master of Nero, whose character both as a man and a writer is discussed with great accuracy by the noble author of the *Characteristics*, a work to which our readers are referred. About the same time lived Persius the satirist, the friend and disciple of the stoic Cornutus, to whose precepts he did honour by his virtuous life; whilst by his works, though few, he showed an early proficiency in the science of morals.

Under the mild government of Hadrian and the Antonines lived Aulus Gellius, or, as some call him, Agellius; an entertaining writer in the miscellaneous way, and well skilled in criticism and antiquity. His works contain several valuable fragments of philosophy, which are indeed the most curious part of them. With Aulus Gellius we may rank Macrobius; not because he was a contemporary, for he is supposed to have lived under Honorius and Theodosius, but from his close resemblance in the character of writer. His works, like those of Gellius, are miscellaneous, being filled with mythology and ancient literature, intermixed with some philosophy. In the same age with Aulus Gellius flourished Apuleius of Madaura in Africa; a Platonic writer, whose matter in general far exceeds in merit his perplexed and affected style, which is but too conformable to the false rhetoric of the age in which he lived.

Boethius was descended from one of the noblest of the Roman families, and was consul in the beginning of the sixth century. He wrote many philosophical works; but his ethical work on the Consolation of Philosophy deserves great encomiums, both for the matter and the style, in which last respect, he approaches the purity of a far better age than his own. By command of Theodoric the king of the Goths this great and good man suffered death; and with him the Latin language, and the last remains of Roman dignity, may be said to have sunk in the western world. There were, besides, a goodly number both of poets and historians who flourished during this period, such as Silius Italicus, Claudian, Ausonius, and others, for a list of whom the reader may consult Fabricii *Bibliotheca Latina*. A number of ecclesiastical writers, some of whom deserve great commendation, also flourished about the same period. The chief of these is Lactantius, who has been deservedly dignified with the proud title of the *Christian Cicero*.

The Roman authors amount to a very small number in comparison of the Greek. At the same time, when we consider the extent and duration of the Roman empire, we are surprised to find so few writers of character and reputation in so vast a field, and think we have good reason to agree with the prince of Roman poets in the sentiment which has been already quoted.

Excellency and usefulness of the Latin language.

Upon the whole, the Latin language deserves our attention beyond any other ancient tongue now extant. The grandeur of the people by whom it was spoken; the high genius of its writers; the empire which it still maintains amongst ourselves; the necessity we are under of learning it in order to obtain access to almost all the sciences, nay even to the knowledge of our own laws, judicial proceedings, and charters; all these circumstances, and many others too numerous to be detailed, render the acquisition of that imperial and universal language in a peculiar manner at once improving and interesting. Spoken by the conquerors of the ancient nations, it partakes of all their revolutions, and bears continually their impression. Strong and nervous whilst they were employed in nothing but battles and carnage, it thundered in the camps, and made the proudest people to tremble, and the most despotic monarchs to bend their stubborn necks to the yoke. Copious and majestic, it became the learned language of Europe, when the Romans, weary of battles, inclined to vie with the Greeks in science and refinement; and by its lustre it caused to disappear the jargon of savages which disputed with it the possession of that quarter of the globe. After having controlled by its eloquence, and humanized by its laws, all those tribes, it became the language of religion; and it will continue to be studied and esteemed as long as good sense and classical taste remain in the world.

SECT. IX. CELTIC, GOTHIC, AND SCLAVONIAN LANGUAGES.

§ 1. *Of the Celtic Language.*

In treating of the origin of the Latin language, we observed that a great part of it had been derived from the Celtic. We shall now endeavour to give some account of the origin and extent of that ancient language, leaving the minutiæ to grammars and dictionaries, as we have done with respect to the other dialects which have fallen under our consideration. The object of this treatise is to discuss questions in philology alone, not to enter into grammatical details, or lexicographical explanations.

The Gauls or Celts.

The descendants of Japhet having peopled the western parts of Asia, at length entered Europe. Some broke into that quarter of the globe by the north, and others found means to cross the Danube near its mouth. Their posterity gradually ascended towards the source of that river; but afterwards they advanced to the banks of the Rhine, which they passed and thence spread themselves as far as the Alps and the Pyrenees.

These people, were, in all probability, composed of different families; all of them, however, spoke the same language; their manners and customs bore a near resemblance; and there was no variety amongst them except that difference which climate always introduces. Accordingly, they were all known, in the more early times, by the general name of *Celto-scythæ.* In process of time, becoming exceedingly numerous, they were divided into several nations, which were distinguished by different names and territorial appellations. Those who inhabited that large country which is bounded by the ocean, the Mediterranean, the Rhine, the Alps, and the Pyrenees, were denominated Gauls or Celts. This people multiplied so prodigiously in the space of a few centuries, that the fertile regions which they then occupied could not afford them the means of subsistence. Some of them now passed over into Britain; others crossed the Pyrenees, and formed settlements in the northern parts of Spain. Even the formidable barrier of the Alps could not impede the progress of the Gauls. They made their way into Italy, and colonized those parts which lie at the foot of these mountains, whence they extended themselves towards the centre of that rich country.

By this time the Greeks had landed on the south-eastern coast of Italy, and founded numerous colonies in those parts. The two nations having each apparently a redundant population, and always planting colonies in the course of their progress, at length met about the middle of the country. This central region was at that period called Latium; and here the two nations formed one society, which was called the Latin people. The languages of both nations were blended together; and hence, according to some, the Latin is a mixture of Greek and of Celtic.

Their language.

As the Gauls were a brave and numerous people, they certainly maintained themselves in their pristine possessions, uninvaded and unconquered, until their civil animosities and domestic quarrels exposed them as a prey to those very Romans whom they had so often defeated, and sometimes driven to the brink of destruction. They were not a people addicted to commerce; and upon the whole, considering their situation both in their primary seats and afterwards in Italy, they had little temptation or opportunity to intermingle with foreigners. Their language, therefore, must have remained unmixed with foreign idioms. Such as it was when they settled in Gaul, such it must have continued until the Roman conquests. If therefore there is one primitive language now existing, it must be found in the remains of the Gaulic or Celtic. It is not, then, surprising, that some very learned men, upon discovering the coincidence of great numbers of words in some of the Greek dialects with other words in the Celtic, have been inclined to establish a strict affinity between these languages. The ancient Pelasgic and the Celtic must at least have nearly resembled each other; admitting only a dialectical difference, and that discrimination which climate and a long period of time must always produce.

Some writers have thought that the Gauls lost the use of their native language soon after their country was conquered by the Romans; but M. Bullet, in his *Mémoires de la Langue Celtique*, has proved almost to demonstration, that the vulgar amongst this people continued to speak it several centuries after that period. When a great and populous nation has for many ages employed a vernacular idiom, nothing can ever make them entirely relinquish the use of it, and adopt unmixed that of their conquerors.

Many learned men, amongst whom is the lexicographer above mentioned, have shown that all the local names in the north of Italy are actually of Celtic extraction. These names generally point out or describe some circumstances relating to the physical character of the situation; such as exposure, eminence, lowness, moistness, dryness, coldness, heat, and the like. This is a very characteristic feature of an original language; and in the Celtic it is so prominent, that the Erse names of places all over Scotland, are, even to the present day, peculiarly distinguished by this quality. We have heard a gentleman, who was well skilled in that dialect of the Celtic still spoken in the Highlands of Scotland, propose to lay a bet at very great odds, that if any one should pronounce the name of any village, mountain, river, gentleman's seat, or other place, in the old Scottish dialect, he would be able, by its very name, to give a pretty exact description of its local situation.

Sources whence t Celtic w derived.

To discover the real sources from which the Celtic language was derived, we must have recourse to various expedients. In the first place, we must consult the Greek and Latin authors, who have preserved some Gaulic or Celtic terms in their writings. Secondly, we must have recourse to the Welsh and *Basse Brétagne* dialects, in which, indeed, there are many new words, though these are easily distinguishable from the primitive stock. Thirdly, if we would trace another source of the Celtic, we must converse with the country people and peasants, who live at a distance from cities, in those countries where this was once the vernacular tongue. We have been credibly informed, that a Highland gentleman crossing the Alps on his way to Italy, accidentally met with an old woman, a native of those parts, who spoke a language so nearly akin to his native Erse, that he could understand her with little difficulty; and that she, on the other hand, understood most of his words. That an event of this nature should actually take place is by no means surprising, when we consider that the dialect spoken in the Highlands of Scotland is perhaps the most genuine remnant of the Celtic now existing, and at the same time reflect that there may be remote cantons amongst those wild and inaccessible mountains, the Alps, where some remains of that tongue may still be preserved. Fourthly, we have said that the most genuine remains of the Gaelic tongue are to be found in the Highlands of Scotland. The reason of this is obvious. The Scottish Highlanders are the unmixed unconquered posterity of the ancient Britons, into whose barren domains the Romans never penetrated; not, we imagine, because they were not able, since they subdued both North and South Wales, equally inaccessible, but because they found no inducement either to excite their ambition or provoke their avarice. Amidst all the revolutions which from time to time shook and convulsed Albion, these mountainous regions were left to their primitive lords, who, though like their southern progenitors, hospitable in the extreme, did not suffer strangers to reside long amongst them. Their language, accordingly, remained unmixed, and in a great measure continues so even unto this day, especially in the most remote parts and unfrequented islands.

The Norwegians subdued the western islands of Scotland, at a time when the Scottish monarchy was still in its minority; and the same people erected a kind of principality over them, of which the Isle of Man was the capital. But though they maintained the sovereignty of these islands for some centuries, built many forts, which they strengthened with garrisons, and were the lawgivers and administrators of justice amongst the natives, yet we have been informed by the most respectable authority, that there is not at this day a single term of the Norse or Danish language to be found in use amongst these islanders. This fact demonstrates the superstitious attachment with which they adhered to their vernacular dialect.

T Welsh di ect.

The Welsh dialect cannot, we should think, be pure and unsophisticated. The Silures were conquered by the Romans, to whom they were actually subject for the space of three centuries. During this period a multitude of Italian exotics must have been transplanted into their language; and indeed many of them are discernible at this day. Their long commerce with their English neighbours and conquerors has also adulterated their language, so that a great part of it is now of an English complexion. The Irish is still spoken by a large portion of the native population of Ireland. The historians of that country have brought the Milesian race from the confines of Asia, through a variety of adventures, to people an island *extra anni solisque vias*. But however much this genealogical fable may please the people for whom it was fabricated, we may still suspect that the Irish are of Celtic extraction, and that their forefathers emigrated from the western coast of Britain at a period anterior to all historical or even traditional annals. Ireland was once the native land of saints; and the principal actors on this sacred stage were Romanists, deeply tinctured with the superstition of the times. They pretended to improve the language of the natives; and whatever their success may have been, they improved it in such a manner as to make it deviate very considerably from the original Celtic; so that it is not in Ireland that we are to look for the genuine characters of the language which we are now considering.

C ci- de be- tw n the C c and P nician.

Though, in our opinion, the Hibernian dialect differs considerably from the original Celtic, yet some very ingenious essays have been published by the learned and laborious members of the *Antiquarian Society of Dublin*, in which the coincidence of that idiom with some of the oriental dialects, has been supported by very plausible arguments. In a dissertation published in the year 1772, the authors have exhibited a collection of *Punico-Maltese* words compared with words of the same import in Irish, and it must be allowed that in these the resemblance is palpable. In the same dissertation they have compared the celebrated Punic scene in Plautus with its translation into the Irish, and shown that the words in the two languages are surprisingly similar. If these criticisms are well founded, they tend to prove that the Celtic is coeval and congenial with the most ancient languages of the East; a conclusion which we think highly probable. But however this may be, the Danes and Norwegians formed settlements in Ireland; and the English have long been the sovereigns of that island. These circumstances must have affected the vernacular idiom of the natives, and not to mention the necessity which the people were under of adopting the language of the conquerors in law, in sciences, and in the offices of religion, they must have contributed much to impair its original purity.

The inhabitants of the Highlands and Islands of Scotland are the descendants of those Britons who fled from the power of the Romans, and sheltered themselves amongst the rocks and fastnesses of those rugged mountains and sequestered glens. They preferred the wastes and wilds of the north, with liberty and independence, to the pleasant and fertile valleys of the south, where plenty was embittered by slavery. They no doubt carried their language along with them, and that language was a branch of the Celtic. With them, probably, fled a number of the druidical priests,[1] who unquestionably knew their native dialect in all its beauties and varieties. In process of time these fugitives formed a regular government, elected a king, and became a considerable state. They were sequestered by their situation from the rest of the world. Without commerce, without agriculture, without the mechanical arts, and without objects of ambition or emulation, they addicted themselves wholly to the pastoral life as their business, and to hunting and fishing as their diversion. This people were not distinguished by an innovating genius; and consequently their language must have remained in the same state in which they received it from their ancestors. They received it genuine Celtic, and such they preserved it.

When the Scots had become masters of the low country, and their kings with a great part of the nobility embraced the Saxon manners, and adopted the Saxon language, the genuine Caledonians still tenaciously retained their native dialect, dress, manners, clanships, and feudal customs, and never cordially assimilated with their southern neighbours. Their language, therefore, could not be polluted with words or idioms borrowed from a people whom they hated and despised. Indeed, it is plain from the whole tenor of the Scottish history, that neither Caledonian chiefs, nor their vassals were ever steadily attached to the royal family after they fixed their residence in the low country, and became *Sassenach*, as the Highlanders called them by way of reproach. Indeed, the commerce between them and those of the south, till about a century and a half ago, was only transient and accidental; nor was their native dialect in any material degree affected by this casual intercourse.

Causes of the purity of this dialect of Celtic.

Their language, however, did not degenerate, because there existed amongst them a description of men whose profession obliged them to guard against that misfortune. Every chief retained in his family a bard or poet laureate, whose province it was to compose poems in honour of his lord, to commemorate the glorious exploits of his ancestors, and to record the genealogy and connections of the family; in a word, to amuse and entertain the chief and his guests at all public entertainments, and upon all solemn occasions. These professors of the poetical art used to contend with each other; and the chiefs of families often assembled their respective bards, and encouraged them by considerable premiums to exert their poetical talents. The victor was rewarded and honoured; and the chief deemed it an honour to himself to entertain a bard who excelled his brethren in song. The ancient Gauls, as we learn from Diodorus Siculus, Strabo, Tacitus, Lucan, and others, entertained persons of that profession; and certainly the ancient Britons did the same. The bards were highly revered; their persons were deemed sacred; and they were always rewarded with salaries in lands or in cattle. The members of this tuneful fraternity must have watched over their vernacular dialect with the greatest care and anxiety; because in their compositions no word was to be lost, and as many as possible gained.

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[1] The probability here assumed cannot very easily be admitted, because we have little else than conjecture to guide us. Mr. Malcolm Laing, in his Dissertation on Ossian, has shown that the opinion expressed in the text is altogether unsupported by any thing deserving the name of evidence; he even contends, that the probability is strongly the other way; and those ancient remains, which have so often been appealed to, as favouring the opinion in question, are considered as of Runic, not Druidical origin. Besides, in the traditional superstitions of the Highlands, there is nothing as far as we know, accords with the account given by Cæsar of the religious rites practised by the British Druids.

The use of letters was not known amongst the ancient *Celtæ;* indeed their druidical clergy forbade the use of them. All their religious rites, their philosophical dogmas, their moral precepts, and their political maxims, were composed in verses which their pupils were obliged to commit to memory. Accordingly letters were unknown to the Caledonian Scots, till they learned them either from their southern neighbours, or from the Romans. The Irish, indeed, pretend to have letters of a very ancient date; but the Highlanders of the country in question make no claim to the use of that invention. Their bards, therefore, committed every thing to memory; and consequently the words of their language must have been faithfully preserved.

In order to exhibit the genius of the Celtic in as striking a light as the nature of our present design will permit, we shall lay before our readers a very short sketch or outline of the Gaelic or Caledonian dialect as it now stands; which, we trust, will go a great way to convince them that the latter is the genuine offspring of the other. In doing this we shall borrow many hints from the work of a gentleman[1] whose learning seems to have equalled his zeal for his native language, which, in compliance with the modern practice, we shall for the future distinguish by the name of Gaelic.

Structure of the Gaelic.

The Gaelic, then, is not as far as we know derived from any other language, being obviously reducible to its own roots. Its combinations are formed of simple words of a known signification; and these words are resolvable into the simplest combinations of vowels and consonants, and even into simple sounds. In such a language we may expect that some traces will be found of the ideas and notions of mankind living in a state of primitive simplicity; and if so, a monument is still preserved of the original manners of the Celtic race whilst as yet under the guidance of simple nature, without any artificial restraint or control.

The sudden sensations of heat and cold, and bodily pain, are expressed by articulate sounds, which, however, are not used in this language to denote heat, cold, or bodily pain. A sudden sensation of heat is denoted by an articulate exclamation *hait;* of cold, by *id;* of bodily pain, by *oich.* All these sounds may be called *interjections,* being parts of speech which discover that the mind is affected by some passion. Few of the improved languages of Europe present so great a variety of sounds which instantaneously convey notice of a particular passion, of bodily pain or mental feeling.

The pronouns *he* and *she* are expressed by the simple sounds *e* and *i,* and these again are the marks of the masculine and feminine genders; for the neuter gender is quite unknown in the Gaelic. The compositions of rude and barbarous ages are universally found to approach to the style and numbers of poetry; and this too is a distinguishing character of the Gaelic. The means of subsistence must always be the principal concern of an uncultivated people. Accordingly *ed* or *eid* is used upon the discovery of any animal of prey or game, and is meant to give notice to the hunting companion to be in readiness to seize the animal; and hence *edo* to eat in Latin, *ed* in Irish, signifying cattle, and *edal* in Scotch, literally signifying the offspring or generation of cattle. *Coed* or *cued,* a share or portion of any subject of property, is literally common food; *faœd,* hunting, literally gathering of food; *edra,* the time of the morning when cattle are brought home from pasture to be milked, literally meal-time. These are words importing the simplicity of a primitive state, and are common in the Gaelic idiom. Traces of imitative language may also be found in all countries. The word used for *cow* in the Gaelic language is *bo,* plainly in imitation of the lowing of that animal.

Excellen of Gaeli compoun

In joining together original roots in the progress of improving language and rendering it more copious, its combinations discover an admirable justness and precision of thought, which one would scarcely have expected to find in an uncultivated dialect. Upon examination, however, it will be discovered that the Gaelic language, in its combinations of words, specifies with accuracy the known qualities, and expresses with precision the nature and properties which were attributed to the object denominated. *An,* for instance, appears to have been a word of frequent use in this language, and seems to have been originally a name applied indefinitely to any object. According to Bullet, it was employed to signify a planet; and hence the *sun* had the name of *grian,* which is a compound of *gri,* hot, and *an* a planet. *Re* signifies originally and radically division. The changes of the moon and the variety of her phases were early employed to indicate the divisions of time. The present name for the *moon* is *geulach,* a word derived from her whiteness of colour. To these we might add a vast number more, the signification of which precisely indicates their shape, colour, effects, or other accidents. Many of these would be found exactly similar to Greek and Latin words of the same sound and signification. In order to satisfy our curious readers, we shall annex a few, though some of them may perhaps be questionable.

The *Venus* of the Latins is supposed to be a compound of *ben* and *jus,* which literally signify the first woman, the letter *b* in Gaelic being softened into *v.* Εδαρ and εἴδαρ signify food. These words are compounded of the Gaelic words *ed* or *eid* and *ar,* the former simply denoting *food,* and the latter *ploughed land;* and they are the roots of the Greek and Latin words ἐδω, *edo;* ἀροω, *aro.* Εδρα, which signifies a seat, has also an evident reference to food. It is compounded of two Gaelic words *ed* and *ira,* which literally signify meal-time. Εδνα, which signifies the presents that a bridegroom made to his bride, is a compound of two Gaelic words *ed* and *na* or *nuah,* literally signifying raw food. From *ar* there are many Greek derivatives. Αρουρα signifies ploughed land, and also a crop of corn; and ἀρτος means bread. In Gaelic *a crop of corn* and *bread* are expressed by *arbhar,* which is commonly pronounced *arar* and *aran,* both being equally derivatives of the root *ar.* So the Greek and Latin words ἀροτος, *arabilis,* arable; ἀροτρον, *aratrum,* a plough; ἀροτηρ, *arator,* a ploughman; and many others, are evidently derived from the same source. From this coincidence, however, we are not prepared to maintain that either the Greek or the Latin languages were derived from the Gaelic; we are rather inclined to think that these are remains of a primeval tongue, which are still retained in all the three, and we produce them upon the present occasion as presumptions that the Gaelic is an original, underived language, and of course the most pure and unadulterated relic of the Celtic now existing.[2]

Copiousness and antiquity of the Celti

When the Celtic language was generally spoken throughout Europe, it seems to have been amazingly copious. By consulting Bullet's *Mémoires,* it will be seen that its names for the common and various objects of nature were very numerous. The words denoting water, river, wood, forest, mountain, lake, and other natural objects, were most precisely accommodated to specify each modification and variety, with such peculiar exactness that even the Greek, with all its boasted idiomatical precision and copiousness, has not been able to equal it. The appearances which diversify the visible face of animated nature, arrest the attention of men in an uncultivated state. Unaccustomed to thought and abstract reasoning, their minds expand and exercise their powers upon sensible objects, and of course mark every minute and almost imperceptible distinction with an accuracy which to us seems impossible. It therefore appears to us, that the Celtic formed one of the dialects of the primitive language; that anciently it overspread by far the greatest part of Europe; and that the Gaelic now spoken in the northern parts of Scotland and the adjacent islands is the purest and most unmixed relic of that language anywhere existing at the present time.

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[1] The writer here referred to is Mr. Grant, whose *Essays* contain much curious information on the subject of which this section treats.

[2] If our readers should incline to know more of this subject, they may consult Pezron's *Origin of Ancient Nations,* Bullet's *Mémoires de la Langue Celtique,* Parson's *Rem. of Japhet,* and Gebelin's *Monde Primitif.*

We would willingly refer our readers to some well arranged Gaelic grammar; but in point of fact we know of none which deserves particular recommendation. That by Dr. Stewart, however, is the best of its class, and considering the difficulty of the undertaking, it must be regarded as a creditable performance, notwithstanding its deficiency in philosophical precision, and simplicity of arrangement. The Dictionary of the Highland Society, in two volumes quarto, and that by Dr. Armstrong, in one volume of the same size, though neither of them, perhaps, what could in all respects be desired, must, nevertheless, afford great facilities to the student of Gaelic.[1] These works, together with the excellent translation of both the Old and New Testaments into Gaelic, which was long a great desideratum amongst the Highlanders, many of whom are still unacquainted with English, will contribute to preserve their ancient tongue, and to disseminate the knowledge of the truth amongst the natives of the mountains.

Every assistance towards acquiring the knowledge of a language which was once diffused over a great part of Europe, is certainly an acceptable present to the public. The antiquary, who is desirous of tracing the affinity of languages, and who wishes to mark the migrations of different races, ought to apply himself to the study of its remaining branches; and, if we are not mistaken, he will soon be convinced, that they all breathe a spirit congenial to the manners and sentiments of people who are just entering upon the first stage of improvement and civilization.

rigin of e words *aul* and *al.*

Perhaps it may be expected, that, before we conclude this short sketch of the Celtic language, we should give some account of the origin of the words *Gaul* and *Gal*, the two names by which this people were distinguished by the Greeks and Romans. Mr. Macpherson imagines, that the appellation of *Celt* is an adjective derived from *Gael*, the aboriginal name of the inhabitants of ancient Gaul. For our part, we can see no connection whatever between *Gael* and *Kelt*, nor do we think that the latter is an adjective. We believe that this people called themselves *Cael* and not *Gael;* and there is little room for doubt that *Caledonia*, that is, *Caldon* or *Cal-dun*, was an ancient name of the mountainous parts of Scotland.

Though many different opinions have been advanced respecting the etymology of this word, we imagine that none is so probable as that which supposes that it is compounded of the two Celtic words, *Cal* or *Kal*, that is, Gal or Gaul, and *dun*, which signifies a hill or mountain. Upon this ground, the *Caledones* will import the Gauls of the mountains, or which is the same, the Highland Gauls. The Irish and Highlanders reciprocally denominate themselves *Cael, Gael,* or *Gauls.* They also distinguish themselves, as the Welsh originally did, and as the Welsh distinguish them both at present, by the appellation of *Guidhill, Guethel,* and *Gathel.* The intermediate *th*, they say, is left quiescent in the pronunciation, as it is in many words of the British language, so that *Gathel* would immediately be formed into *Gael;* and Gathel is actually sounded like *Gael* both by the Irish and by the Highlanders. The appellation of *Gathel*, therefore, say they, was originally the same with *Gael*, and the parent of it. The quiescent letters in the British are frequently transferred from the middle to the conclusion of the word; by which means *Gathel* is changed into *Galath, Galat, Galt,* and *Celt.* It is true, that the *Gael* of the continent are universally denominated *Galatæ* and *Celtæ* by the Grecians, and *Gallt* and *Gallta* by the Irish. The appellations, therefore, of *Gathel-i, Gall-i, Gallat-æ, Calet-es, An-calit-es,* and *Celt-æ,* are all one and the same denomination, only varied by the astonishing ductility of the Celtic, and disguised by the alterations ever incident to a language which has for ages been merely oral.[2]

It may perhaps appear presumptuous in us to differ from two such respectable authorities as Macpherson and Whitaker; but we must, nevertheless, acknowledge, that neither the one nor the other appears to us to be well founded in his views. Besides, they convey no idea of the signification of the words, though in the Celtic language these must have been significant. The name *Cael*, the same with *Gal*, was probably given them in the East from the Greek καλ, which in many oriental languages denotes *fair;* and γαλατια may be easily derived from γαλ or γαλαθ, *Gal* or *Galath;* a denomination which might be given them by their neighbours, in allusion to their fair complexion.

§ 2.—*Of the Gothic Language.*

Ancient Gothic.

The Celtic and Gothic languages at one period divided Europe between them. Both were of equal antiquity, both originated in Asia, and both were dialects of the original language of mankind. The Celtic, however, was first imported into Europe. The Gauls or Celts had penetrated farthest towards the west, a circumstance which plainly intimates the priority of their arrival. In the population of countries, it may be held as a maxim, that the colonies who first emigrated were generally impelled by succeeding emigrants; and that consequently the most early were pushed forward to the parts most distant. The Celts, then, having overspread the most western parts of Europe, must have been the first who established themselves in those regions.

The same with the language of the Thracians.

The Goths and Getæ were the same race of people, according to Procopius[3]; and Strabo informs us, that they spoke the same language with the Thracians, from whose confines they had spread themselves northward as far as the western banks of the Danube.[4] Vopiscus, in the History of Probus, tells us, that this emperor obliged "the Thracians, and all the Getic tribes, either to surrender or accept of his friendship," an expression which indicates, that the Thracians and the Getic tribes were deemed the same race of people.[5] From this deduction then, it is clear, that the Getæ and Thracians were brethren, and spoke the same language;—and that their laws, manners, customs, and religious tenets, were the same, might easily be shewn, were this the proper place for such an inquiry. The Thracian language, as might be demonstrated from names of persons, offices, places, and customs, amongst the people who spoke it, was nearly related to the Chaldaic and other oriental languages.

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[1] The Dictionary of the Highland Society is executed with great ability to the extent of between two-thirds and three-fourths of the whole; but the subsequent portion betrays that it had fallen into inferior hands; and some of the Latin definitions are such as can scarcely fail to astonish the accurate scholars of the Continent. The death of Mr. Maclachlan, of Aberdeen, the original conductor, proved a great calamity to the work. Equally eminent as a classical, oriental, and Celtic scholar, and profoundly learned in philology, his place could not be supplied; and though occasional assistance was obtained from men equally conversant with Latin and with Celtic, such as the late Rev. Mr. Macdonald of Crieff, the elegant author of the *Phingaleis*, yet the master mind was removed, and the work suffered in consequence. Still, with all its acknowledged defects, it is a valuable present to the philologist as well as the scholar, and does honour to the liberal and patriotic spirit of the National Association under whose auspices it was brought out.

[2] We must caution our readers, however, not to confound *Gael* with *Gal* or *Gall*, which, in the Celtic, signifies a stranger.

[3] *De Bello Gothico*, lib. i. c. 2.

[4] Lib. ii. cap. 23.

[5] Lib. vii. p. 295; ibid. p. 305, Casaubon. From this passage it appears, that the Greeks were of opinion that the Getæ were Thracians. Pliny (*Nat. Hist.* lib. iv. cap. 11.) mentions a tribe of the Getæ called *Gaudæ*.

Origin of the Goths.

The Goths are thought to have been the descendants of Tiras, one of the sons of Japhet, and consequently must have preserved the speech of the Noachic family. The Gothic language abounds with Pahlavi, or old Persian words, which are no doubt remains of the primitive dialect of mankind. The Thracians peopled a considerable part of the northern coast of Asia Minor; and consequently we meet with many names of cities, mountains, rivers, and other objects in those parts, exactly corresponding with many names in Europe, evidently imposed by our Gothic progenitors. These any person tolerably acquainted with the remains of the Gothic language, will be able to trace with little difficulty.

We learn from Herodotus,[1] that Darius in his expedition against the wandering Scythians who lived on the other side of the Ister or Danube, subdued in his progress the Getæ; and in the same passage the historian informs us, that this people held the immortality of the human soul, and were the bravest and justest of all the Thracians. After this period, we find them mentioned familiarly by almost every Greek writer; for, in the comedies of that nation, Geta is a common name for a slave. The Getæ then occupied all that large tract of country which extended from the confines of Thrace to the banks of the Danube; they were a brave and virtuous people, who spoke the same language as the Thracians, with whom they are often confounded both by the Greek and the Roman historians. But the name of Goths is not by any means so ancient. It was utterly unknown to the ancient Greeks and Romans. The first time that the name Goth is mentioned is in the reign of the emperor Decius, about the year of Christ 250. About that period they had burst out of Getia, and rushing like a torrent into the empire, laid waste every thing with fire and sword. The name of their leader or king was *Cneva*; and Decius, in endeavouring to expel them from Thrace, was vanquished and slain.

After this irruption, we find them frequently mentioned by the Latin authors under the name of *Getæ* or *Gothi*, though the Greeks generally denominate them *Scythæ*. Torfæus tells us, that *get* and *got* are in reality the same word, and according to him, anciently denoted a soldier.[2] *Got* in Icelandic signifies a horse or horseman, and *gata* a wanderer; and this was perhaps the import of the term *Geta*, because the *Getæ* were originally an unsettled and vagrant people. As nations generally assume to themselves some high and auspicious denomination, it may be presumed that the Goths did the same. We may therefore be satisfied, that the Getæ assumed the Icelandic name above mentioned as their national one; or perhaps, that, notwithstanding their Greek denomination, they from the beginning called themselves *Gots* or *Goths*.

Primary seat of the Goths.

The original seat of the Goths was the country now called Little Tartary, into which they had extended themselves from the frontiers of Thrace. This country was called Little Scythia by the Greek writers; and it was the station whence those innumerable swarms advanced, which, in conjunction with the Alani and other barbarous tribes, at length overran and subverted the western empire. One part of the Gothic nation was allowed by Constantine to settle in Mœsia. Before the year 420 of our era, most of the Gothic nations who had settled within the limits of the Roman empire had been converted to the Christian faith; but, unhappily, the greater part of the apostles by whom they had been proselytized were Arians; and this proved fatal to many of the orthodox Christians, whom the Arian Goths persecuted with unrelenting cruelty.

Remains of genuine Gothic.

About the year 367, Ulphilas, bishop of the Mœsian Goths, translated the New Testament into the language of that people. The remains of this translation furnish a genuine, and at the same time a venerable, monument of the ancient Gothic dialect. Of that valuable translation no more is now extant than the four Gospels, and another fragment containing part of the epistle to the Romans. The Gospels have been repeatedly published since the first edition by Junius which appeared in the year 1665. There have also been discovered other fragments of the Gothic language which the curious reader may find in Lye's notes to his edition of the Gothic Gospels. The fragment of the Epistle to the Romans was discovered in the library at Wolfenbuttle, and published by Knitel arch-deacon of Wolfenbuttle, as has been fully explained in another article of this work (Palimpsests). Prior to the age of Ulphilas, the Goths were ignorant of the use of alphabetical characters. But that bishop fabricated for them an alphabet, which consists of a medley of Greek and Roman letters, though rather inclining to the former.

Gothic alphabet.

The Gothic alphabet is composed of twenty-five letters. Junius has carefully analyzed these letters, and pointed out their powers and sounds, in the alphabet prefixed to his *Glossarium Gothicum*. They were long retained in all the European languages which acknowledged the Gothic as the source whence they had been derived, and which will be enumerated in the sequel.

Origin of the Gothic language.

What kind of language the ancient Gothic really was, may be inferred from the fragments above mentioned; but in what respects it agrees with the oriental tongues, or differs from them, is not easy to ascertain with precision. In the section on the Greek, we have observed that a considerable part of that language must have been derived from the Thracian, which, according to Strabo, was the same with the Getic or Gothic; and we are convinced that the Thracian language will, on comparison, be found analogous to the Chaldaic or Syriac. The German, which is a genuine descendant of the Gothic, is full of Persian words; and the old Persian or Pahlavi appears to have been a dialect of the Chaldaic. Junius, in his treatise on the Gothic alphabet, remarks that a very considerable part of the Gothic language is borrowed from the most ancient Greek; but, perhaps, it would have been nearer the truth, if he had reversed this observation, and stated that the ancient Greek was in a great measure derived from the Gothic.

The learned Ihre in his *Glossarium Suio-Gothicum*, and Wachter in his excellent German and Latin Dictionary, remark the coincidence of Gothic and German words with oriental nouns of a similar sound and the same signification. In the old Saxon, which is another ramification from the Gothic stem, numberless terms of the very same complexion appear. Hence it appears that the Gothic in its original and unmixed state as spoken by the ancient Getæ, was a dialect of the primeval language, which the sons of Tiras had brought with them from the plains of Shinar, Armenia, or some other region, where "the world's grey fathers" had fixed their residence.

The Thracian tribes, in all probability, first took possession of those parts of Asia Minor which stretch towards the east; and thence crossing the Hellespont, they spread themselves northward. Strabo supposes that they first settled in the regions to the north of this strait, and thence transported numerous colonies into Asia Minor. The reverse was probably the case; but be this as it may, it is universally agreed, that both sides of the Hellespont were at one time peopled with Thracians.

In Asia Minor we meet with the city Perga, which, throwing away the *a*, is *Perg*. But in every tongue descended from the Gothic, the word *Berg* signifies a rock, and metaphorically a town or burgh, because towns were originally built upon rocks for the sake of defence. Hence likewise *Pergamus*, the fort or citadel of Troy. *Beira*, in Thracian, signified a city; whilst the Chaldaic and Hebrew word *Beer* imports a well, and is possibly the original of the Gothic word *beer*, ale. In ancient times, especially in the East, it was customary to build cities in the neighbourhood of fountains. The ancients called the Phrygians Βρυγες, *Bryges*, or *Bruges*, a name which is obviously of Gothic origin. *Dyndymus*, the name of a city sacred to Cybele, is compounded of two Gothic words *dun* and *dum*, both signifying a height or an eminence, and hence a town or an inclosure. The word *tros* seems to be the Gothic word *trosh*, signifying brave, valiant. The words *fader*, *mader*, *dochter*, *bruder*, are so obviously Persian, that almost every etymologist has assigned them to that language.

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[1] Lib. iv. *passim*.

[2] *History of Norway*, lib. i.

Many futile etymologies have been given of the sacred name *God*, which is in reality the Persian word *Choda*, commonly applied by them to their Hormuzd or Oromasdes. The Persian *bad* or *bod* signifies a city; and the same word in Gothic imports a house, a mansion, an abode. *Band*, in Persian, is a strait place; in Gothic, it signifies to bend. *Heim* or *ham*, a house, is generally known to be of Persian origin. Much critical skill has been displayed in tracing the etymology of the Scotch and old English word *Yule* or Christmas. *Yule*, derived from *iul*, was a festival in honour of the sun, which was originally celebrated at the winter solstice. *Wick* or *wich* is a Gothic term still preserved in many names of towns; it signifies a narrow corner, or small strip of land jutting into the sea, or into a lake or river; hence the Latin *vicus*, and Greek φοικος. In Spanish we have many old Gothic words, and amongst the rest *hijo*, a son, the same with the Greek ὑιος. In some places of Scotland we call any thing that is little, or small, *wee*, originally spelled *wi*, which if we mistake not, is formed from the very same word.

These examples we have thrown together, without any regard to order, being persuaded that almost every word of the language, which is truly Gothic, may with a little pains and judgment be traced to some oriental root or cognate term. We may observe in passing, that many Gothic nouns end in *a*, like the Chaldaic and Syriac; that their substantive verb very much resembles that of the Persian, Greek, and Latin; and that their active and auxiliary verb has furnished the common preterperfect tense of Greek verbs in the active voice. That verb is *haban*, but was originally *ha*, as the common people pronounce it at this day, especially in the north of Scotland, and amongst the Swedes, Danes, Norwegians, and Icelanders.

dern ects de- d from Gothic.

Leaving the inferior arrangements of this ancient language to grammarians and lexicographers, we shall now proceed to inquire what modern tongues have been derived from it as their source, and which of them makes the nearest approach to its simplicity and rusticity. We have already observed that the Goths, formerly Getæ, were possessed of a vast extent of country, reaching from the frontiers of Thrace to the banks of the Ister or Danube. We have also seen that a colony of them settled in Mœsia under Constantine II.; after which they spread themselves throughout Dacia, and thence passed into Germany. All these countries were situated in such a manner, that the progress of population was commensurate with the natural course of emigration. From Germany they extended themselves into Scandinavia, that is, Sweden, Denmark, and Norway. All the ancient Edda, Sagas, and Chronicles, shew that the Goths arrived in Scandinavia by this route, without, however, fixing the era of that event with any tolerable degree of accuracy. By the Germans, the ancients most probably understood all the nations eastward, westward, and northward, reaching from the Danube on the south to the extremity of Scandinavia in the northern ocean, and from the Rhine and German ocean on the west, to the river Chronus or Niemen on the east. But all the nations included within these limits spoke one or other of the Gothic dialects, some approaching nearer, and others deviating farther from, the parent language.

The Francic is plainly a dialect of the Teutonic, Tudesque, or old German; and the Gospels of Ulphilas bear such a resemblance to the Francic, fragments of which are preserved in the early French historians, that some learned men have pronounced these gospels part of an old Francic version; but others of equal respectability have refuted this opinion, both from history and a comparison of the dialects. Schilter has given us several specimens of the Tudesque or old German in the seventh century, which evidently prove that the Gothic of Ulphilas is the same language; and Wachter's learned glossary of the ancient German confirms the position of Schilter. Ihre, after hesitating whether the Gospels of Ulphilas bear most resemblance to the German or Scandinavian dialect of the Gothic, declares at last in favour of the former. The Anglo-Saxon is also known to be a venerable dialect of the Tudesque; and is so intimately connected with the gospels, that some valuable works on this subject are wholly built upon that supposition.

The Icelandic is the most ancient relic of the Scandinavian. It begins with Arius Frode in the eleventh century, and is a dialect of the German. The remains we have of it are more modern by four centuries than those of the German; and they are also more polished. The words are shortened, not only because they are more modern than the German, but because the Icelandic was polished by a long succession of poets and historians almost equal to that which does so much honour to Greece and Rome. Hence the Icelandic, being a more polished language than the German, has less affinity with the parent Gothic. The Swedish is more nearly related to the Icelandic than either the Danish or Norwegian. That the Swedish is the daughter of the Gothic, has been very clearly shewn by Ihre, in his *Glossarium Suio-Gothicum*. There is, therefore, no manner of doubt as to the identity of the Gothic, preserved in Ulphilas and other ancient remains, with the German and Scandinavian tongue. The modern German, resembles the Gothic Gospels more than the present Danish, Norwegian, or Swedish, and has certainly more ancient *stamina*. Its resemblance to the Asiatic tongues, in harshness and inflexible thickness of sound, is likewise very apparent.[1]

Busbequius shews that the peasantry of Crim Tartary, who are remains of the ancient Goths, speak a language almost German. These peasants were no doubt descendants of the ancient Goths, who remained in their native country after the others had emigrated. It is therefore apparent from the whole of this investigation, that the Gothic was introduced into Europe from the East, and that it is probably a dialect of the language originally spoken by the founders of human society.

§ 3.—*Of the Sclavonian Language.*

Sclavonic language.

There is another language which pervades a considerable part of Europe, and which, like the Gothic, seems to have originated in the East. The language we allude to is the Sclavonic or rather Slavonic, which prevails to a great extent in the eastern parts of this division of the globe. It is spoken by the Dalmatians, by the inhabitants of the Danubian provinces, by the Poles, Bohemians, and Russians. The word *slab*, that is, slave, whence the French word *esclave*, and our word *slave*, signifies noble, illustrious; but because in the lower ages of the Roman empire, vast multitudes of this people were spread over all Europe in the quality of slaves, that word came to denote the servile tribe by way of distinction, in the same manner as the words *Geta*, *Davus*, and *Syrus*, did amongst the Greeks at a more early period.

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[1] It is a pity that the learned author of this treatise did not pursue the ingenious and profound thought which here suggested itself to his mind. If he had done so, he would, beyond all question, have anticipated the continental philologists in the discovery of a new principle of classifying languages, and more particularly in separating from the mass that great family which has been so aptly denominated Indo-European. But all the elements of the new classification are to be found in the present treatise. The affinity of the Greek and the Gothic, the parentage of the old German, and the oriental origin of both, are as distinctly intimated as in any of the works of Klaproth or his contemporaries; and if the author had known Sanscrit, he would, at the first glance, have anticipated the most important discovery which has rewarded the philological research of the nineteenth century.

Slavi.

The Slavi dwelt originally upon the banks of the Borysthenes, now called the Dnieper or Nieper. They were one of the tribes of the European Sarmatians, who in ancient times inhabited an immense tract of country, bounded on the west by the Vistula, and on the south-east by the Euxine or Black Sea, the Bosphorus Cimmerius, the Palus Mæotis, and the Tanais or Don, which divides Europe from Asia. In this vast tract of country, there dwelt aboriginally many considerable tribes. To enumerate these, however, would not much edify our readers; and we shall only inform them, that amongst the Sarmatian clans were the Roxolani, now the Russians, and likewise the Slavi, who dwelt near the Borysthenes. The Slavi gradually advanced towards the Danube; and in the reign of Justinian having passed that river, they made themselves masters of that portion of Illyricum which lies between the Drave and the Save, and is to this day called *Sclavonia*. By degrees these barbarians overran Dalmatia, Liburnia, the western parts of Macedonia, and Epirus; and on the east they extended their conquests to the western bank of the Danube, where that river falls into the Euxine. In all these countries the Sclavonian was deeply impregnated with the Greek; which indeed was a matter of course, as the barbarian invaders settled in these regions, and mingled with the aborigines, who spoke a corrupt dialect of the Greek language.

The Poles, &c.

The Poles are the genuine descendants of the ancient Sarmatians,[1] and consequently speak a dialect of the language of that race, though much adulterated with Latin words, in consequence of the attachment this people have long professed to the Roman tongue. The Silesians and Bohemians have corrupted their dialects in a similar manner. In these countries, then, we are not to search for the genuine remains of the ancient Sarmatian.

Russians.

The modern Russians, formerly called Rhoxani or Roxolani, are the posterity of the Sarmatæ, and constitute a branch of the Slavi. They inhabit a part of the country which that people possessed before they fell into the Roman provinces; they also speak the same language, and wear the very same dress. If then the Slavi are Sarmatæ, the Russians must of course be the descendants of the same people. They were long a sequestered people, and consequently altogether unconnected with the other nations of Europe. They were unacquainted with commerce, inhospitable to strangers, tenacious of ancient usages, averse to improvements of every kind, wonderfully proud of their imaginary importance, and, in a word, a race of men just one degree above absolute barbarism. A people of this character are, for the most part, enemies to innovations; and if we may believe the Russian historians, no nation was ever more averse to changes than their own. From the ninth century, at which era they embraced Christianity, it does not appear that they moved one step forward towards civilization, until Peter the Great, little more than a century ago, compelled them by his despotic authority to adopt the manners and customs of their more polished neighbours.

We may then conclude, that, during the period in question, the Russians made as little change in their language as they appear to have done in their dress, habits, and manner of living. Whatever language they spoke in the ninth century, the same they employed at the beginning of the eighteenth. They were, indeed, according to Appian, once conquered by Diophantus, a general of Mithridates; but that conquest was for a moment only. They were likewise invaded, and their country was overrun, by the great Timur or Tamerlane; but this invasion proved like a torrent from the mountains, which spreads devastation far and wide whilst it rages, but makes little alteration on the face of the country. We find, likewise, that upon some occasions they made incursions upon the frontiers of the Roman empire; but we hear of no permanent settlements formed by them in the countries which they overran. Upon the whole, the Russians, with respect to their language, were in nearly the same predicament with the Highlanders and Islanders of Scotland, who, according to the general opinion, have preserved the Celtic dialect pure and entire, solely from their never having mingled with foreigners.

The Russian genuine Sclavonic.

From this deduction we may infer two things; first, that the Russian language is the genuine Sclavonian; and, secondly, that the latter is the same, or nearly the same, with the ancient Sarmatian. In the Russian, there are found a great number of words resembling, both in sound and signification, the old simple roots of the Greek; its grammatical genius is nearly the same; and we are informed by the very best authority, that there exists in this language a translation of Epictetus, in which there are whole pages, both in the original and the translation, without one single transposition. M. Lévêque, who published a translation of a history of Russia, was so entirely convinced of the strict analogy between the ancient Greek and the modern Russian, that he became positive as to the former having been derived from the latter. M. Fréret, a very learned French academician, also adopted the same opinion. We are persuaded, however, that this opinion is ill-founded, and rather conceive, that these coincidences arise from the relics of the primitive language of mankind, vestiges of which, we believe, are to be found almost in every tongue now extant.

It is, however, we admit, exceedingly difficult to render a reason for the syntaxical analogy of the two languages, without admitting the truth of the one or other of the hypotheses mentioned. We have examined with some care a goodly number of Russian words, and compared them with Greek words of the same signification; but we have not found such a resemblance as we consider necessary to support the position above advanced. We have indeed discovered a very strong resemblance between the former and many oriental words, especially Hebrew, Chaldaic, and old Persian, of which we could produce several instances, did the nature of our present inquiry admit such a deviation. Every body knows that the Sarmatians were divided into two great nations, the Asiatic and the European. The former extended very far to the eastward, behind the mountain Caucasus, the northern shore of the Euxine Sea, and probably derived their language from the original form of speech long before the Greek language existed. But this, in comparison with the Hebrew, Phœnician, Egyptian, Arabian, and Chaldean, was but of yesterday. The Greek, most learned men are now convinced, was a late composition of many different dialects, incorporated with the jargon of the aboriginal Ionim or Greeks. The Sarmatian, on the contrary, was the language of a great and populous nation, civilized, in all appearance, long before the Greeks began to emerge from a state of barbarism. We are, therefore, by no means disposed to allow, either that the Greek is derived from the Russian, or that the Russian is derived from the Greek. We believe there is just the same reason for this conclusion, that the Abbé Pezron and M. Gebelin pretend to have discovered, for supporting their position that the Greek is derived from the Celtic. Certain it is, that the resemblance amongst the oriental languages, of which we conceive the Sarmatian to have been one, is so palpable, that any person of moderate capacity who is perfectly master of one, will find but little difficulty in acquiring any other. If, therefore, the coincidence between the Greek and Russian should actually exist, we think this circumstance will not authenticate the supposition, that either of the two is derived from the other.

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[1] This appears by their character, their laws, their manners, their form of government, their military equipage, their impetuosity, their aristocratic splendour.

In the course of this argument, our readers will be pleased to observe, that we all along suppose, that the Sclavonian, of which we think the Russian is the most genuine remain, is the same with the old Sarmatian. We shall now take the liberty to hazard a conjecture with respect to the syntaxical coincidence of that language with the Greek; for we acknowledge that we are not so profoundly versed in the Russian dialect of the Sclavonian as to pretend to pronounce a definitive sentence.

Syntactical coincidence between this language and the Greek.

As the Russians were a generation of savages, there is no probability that they were acquainted with the use of letters and alphabetical writing until they acquired that art by intercourse with their neighbours. It is certain that few nations had made less proficiency in the fine arts; and there is little appearance of their having learned this art previously to their conversion to Christianity. It appears, indeed, that the Slavi, who settled in Dalmatia, Illyria, and Liburnia, had no alphabetical characters till these were furnished with them by St. Jerome. The Servian character, which very nearly resembles the Greek, was invented by St. Cyril; and on this account the language written in that character is denominated *Chiurilizza.* But these Sclavonic tribes knew nothing of alphabetical writing prior to the era of their conversion; and the Mœsian Goths were in the same condition till their bishop Ulphilas fabricated for them a set of letters. If, then, the Slavi and Goths, who resided in the neighbourhood of the Greeks and Romans, had not learned alphabetical writing prior to the era of their conversion to Christianity, it follows, *a fortiori*, that the Russians, who lived at a great distance from these nations, knew nothing of this useful art antecedent to the period of their embracing the Christian faith.

The Russians pretend that they were converted by St. Andrew; but this is known to be a fable. Christianity was first introduced amongst them in the reign of the grand duke Woladimir, who having married the daughter of the Greek emperor, Basilius, became her convert about the year 989. About this period they were taught the knowledge of letters by the Grecian missionaries, who were employed in teaching them the elements of the Christian doctrines. Their alphabet consists of thirty-one letters, with a few obsolete additional ones; and these characters resemble so exactly those of the Greeks that there can be no doubt of their being copied from them. It is true, the shape of several has been somewhat altered, and a few barbarous characters have been intermingled. The Russian liturgy, as every body knows, was copied from that of the Greeks; and the best specimen of the old Russian is to be found in the church offices for Easter, which are in the very words of Chrysostom, who is called by his name *Zlato ustii,* or golden-mouthed. The power of the clergy in Russia was excessive; and their influence was, no doubt, proportioned to their power. The first race of clergy in that country were undoubtedly Greeks, because we know how active and industrious that people were in propagating their language as well as their religion. The offices of religion might at first be written and pronounced in the Greek language, but it would soon be found expedient to have them translated into Russian; and the persons employed in this work must have been Greeks, who understood both languages.

As it is confessedly impossible that a people so dull and inattentive as the Russians originally were, could ever have fabricated a language so artificially constructed as their present dialect; and as it is obvious, that, until Christianity was introduced amongst them by the Greeks, they could have no correspondence with that people; it must appear surprising by what means their language came to be fashioned so exactly according to the Greek model. We have observed above, that the Russian letters must have been invented and introduced into that country by the Greek missionaries; and we think it probable, that these apostles, at the same time that they taught them a new religion, likewise introduced a change into the idiom of their language. The influence of these ghostly teachers over a nation of savages must have been almost boundless, the force of their precepts and example almost uncontrollable. But if the rude and savage converts accepted a new religion from the hands of Grecian apostles, they might with equal submission adopt improvements in their language. Such of the natives as were admitted to the sacerdotal function must have learned the Greek language, in order to qualify them for performing the offices of their religion; and a predilection for that language would be the immediate consequence. Hence the natives, who had been admitted into holy orders, would co-operate with their Grecian masters in improving the dialect of the country, which, prior to the period above mentioned, must have greatly deviated from the original standard of the Sarmatian language.

Upon this occasion the Grecian apostles, in conjunction with their Russian disciples, probably reduced the language of the country to a resemblance with the idiom of the Greek. They retained the radical terms as they found them, but by a variety of flections, conjugations, derivations, compositions, and other modifications, transformed them into the Grecian air and apparel. They must have begun with the offices of the church; and amongst a nation of newly converted savages, the language of the religion they had been induced to adopt, would quickly obtain a very extensive circulation. When the Grecian garniture was introduced into the church, the laity would in process of time assume a similar dress. The fabric of the Greek declensions, conjugations, and inflections, might be grafted upon Russian stocks without affecting the radical parts of the language. If the dialect in question, like most others of a very ancient date, laboured under a penury of words, such a device would contribute exceedingly to supply that defect. By this expedient the Greek language itself had been enlarged from about three hundred radical terms to the prodigious number of words of which it now consists.

The Latin language, in its original constitution, differed widely from the Greek; but notwithstanding this incongruity, the improvers of the former have pressed it into a very strict agreement with the latter. This, we think, was a still more difficult task, because the genius of the Latin differs in a much greater degree than that of the Russian does from the genius of the Greek. We know that the Gothic language and all its descendants are, in their essential character, much more in unison with the Greek than they are with the Latin. The Spanish, Italian, and French, have cudgelled many of their Gothic, Teutonic, and Celtic verbs, into a kind of conjugations, imitating or rather aping those of the Latin. The Persians have also formed most elegant and energetic declensions and conjugations, upon inflexible roots borrowed from the Pahlavi and Deree, and even from Tartarian originals.

Upon the grounds above mentioned we now take the liberty to hazard the following conjectures, which we cheerfully submit to the cognizance of more enlightened philologists, viz. 1. That the Sarmatian was a dialect of the original language of mankind; 2. That the Sclavonian was a dialect of the Sarmatian; 3. That the Russian is the most genuine and unsophisticated relict of the Sclavonian and Sarmatian; 4. That the Russians had no alphabetical characters prior to the era of the introduction of Christianity, that is, towards the end of the tenth century; 5. That they were converted by Grecian missionaries; 6. That these missionaries formed their present letters from those of Greece, and, in conjunction with the more enlightened natives, reduced the original and unimproved Russian to its present resemblance to the Grecian standard.

Russian parts of speech.

The Russian language, like most others, contains eight parts of speech. Its nouns have three genders, masculine, feminine, and neuter; and it has also a common gender for nouns, intimating both sexes. It has only two numbers, singular and plural. Its cases are seven, nominative, genitive, dative, accusative, vocative, instrumental, and prepositive. These cases, however, are not formed by varying the termination, as in Greek and Latin, but generally by placing a vowel after the word, as, we imagine, was the original practice of the Greeks. Thus in Russian, *ρυκ*, *ruk*, the hand; nominative, *ρυκ-α*, the hand; genitive, *ρυκ*-Nʼ of the hand.[1] Nouns substantive are reduced to four declensions, but adjectives constitute a fifth. The latter agree with their substantives in case, gender, and number; and they have three degrees of comparison, as is common in other languages, viz. the positive, comparative, and superlative. The comparative is formed from the feminine of the nominative singular of the positive, by changing *a* into *te*, that is, *aie* in English; and the superlative is formed by prefixing *πρε*, *pre*, before the positive. These rules are general; with regard to the exceptions, recourse must be had to a Russian grammar.

The numeral adjectives in Russian have like the rest three genders, and they are declined accordingly. Their pronouns have nothing peculiar, being divided and arranged in the same manner as in other languages. Verbs in the Russian language are comprehended under two conjugations. The moods are only three; the indicative, the imperative, and the infinitive. The subjunctive is formed by placing a particle before the indicative, and its tenses are eight in number; the present, the imperfect, the preterite simple, the preterite compound, the pluperfect, the future indeterminate, the future simple, the future compound. The verbs have their numbers and persons as in other languages. To enter into a detail of the manner of conjugating Russian verbs would neither be consistent with our plan, nor of much consequence to our readers. The remaining parts of speech differ in nothing from those of other languages. The syntax of Russian nearly resembles that of the Greek and Latin. But all these accidents must be learned from a grammar of the language. We could have wished to be able to gratify our readers with a more authentic account of the origin of the Sclavonic language; but this we find impossible, owing to the want of materials relating to the state of the ancient Sarmatæ. Towards the era of the subversion of the western empire, the nations who inhabited the countries in question were so blended and confounded with each other, and with Huns and other Scythian or Tartar tribes, that the most acute antiquarian would find it impossible to investigate their respective dialects, or even to fix their original residence and extraction.

Phœnician and Chaldean words in Russian.

We have selected the Russian as the most genuine branch of the old Sclavonic, and to this preference we were determined by the reasons above mentioned. We are not sufficiently acquainted with the idiom of the Russian language to be able to compare it with those of the East; but were such a comparison made we are persuaded that the radical materials of which it is composed would be found to have been of oriental origin. The word *Tsar*, for example, is probably the Phœnician and Chaldean *Sar*, or *Zar*, a prince, or grandee. Diodorus Siculus calls the queen of the Massagetæ, who, according to Ctesias, cut off the head of Cyrus, *Zarina;* which still continues to be the national title of the empress of all the Russias. Herodotus calls the same princess *Tomyris*, which is the very name of the celebrated Timur or Tamerlane the conqueror of Asia. The former seems to have been the title, and the latter the proper name, of the queen of the Massagetæ. In the old Persian or Pahlavi, the word *gard* signifies a city. In Russian, *gorod* or *grad* intimates the very same idea; and hence Constantinople in old Russian is called *Tsargrad* or *Tsargorod*. These are only a few specimens; but skilful etymologists might, we believe, discover a great number more.

The Sclavonian language is spoken in Epirus, in the western part of Macedonia, in Bosnia, Servia, Bulgaria, in part of Thrace, in Dalmatia, and Croatia, in Poland, Bohemia, Russia, and Mingrelia, and hence it is frequently used in the seraglio at Constantinople. Many of the great men of Turkey understand it, and frequently use it; and all the janizaries who had been stationed in garrisons on the Turkish frontiers in Europe, formerly used it in their ordinary intercourse. The Hungarians, however, and the natives of Wallachia, speak a different language, one which bears evident marks of Tartarian origin, in short a dialect of that language which was spoken by the original Huns. Upon the whole, the Sclavonic is one of the most widely spread languages in Europe, and even extends far into Asia.

SECT. X. MODERN LANGUAGES.

Parent dialects of Europe.

If the different dialects of the various nations which now inhabit the earth, be called languages, the number will be truly great; and vain would be the ambition of that man who should attempt to acquire them, however imperfectly. But there are four, which may be considered as original or mother-languages, and which seem to have given birth to all that are now spoken in Europe. These are the Latin, the Celtic, the Gothic, and the Sclavonic. Let it not, however, be imagined, from the term *original* applied to these languages, that we believe them to have come down to us, without any alteration. We have repeatedly declared our opinion, that there is but one truly original language, from which all others are derivatives variously modified. The four languages just mentioned are original only as being the immediate parents of those which are now spoken in Europe.

Thus, from the *Latin* came, the Portuguese, the Spanish, the French, and the Italian. From the *Celtic* came, the Erse or Gaelic of the Highlands of Scotland, the Welsh, the Irish, and the Basse Bretagne. From the *Gothic* came, the German, the Low Saxon or Low German, the Dutch, the English, in which almost all the noun-substantives are German, and many of the verbs French or Latin, and which is enriched with the spoils of all other languages, including the Danish, the Norwegian, Swedish, Icelandic.

From the *Sclavonian* came, the Polish, the Lithuanian or Lettish, the Bohemian, Transylvanian, Moravian, and the modern Vandalian, as it is still spoken in Lusatia and other parts; the Croatian, the Russian or Muscovite, which, as we have seen, is the purest dialect of this language; the language of the Calmucks and Cossacks; with thirty-two different dialects of nations who inhabit the north-eastern parts of Europe and Asia, and who are descended from the Tartars and Hunno-Scythians. There are polyglott tables containing not only the alphabets, but also the principal or distinctive characteristics of all these languages.

Asiatic Languages.

The languages which are at present spoken generally in Asia are, the Turkish and Tartarian, with their different dialects; the Persian, the Georgian or Iberian, the Albanian or Circassian, the Armenian, the modern Indian, the Formosan, the Hindustanee, the Malabarian, the Warugian, the Tamulic or Damulic, the modern Arabic, the Tongussian, the Mongolian, the language of the Nigarian or Akar Nigarian, the Grusinic or Grusinian, the Chinese, and the Japanese. Here, however, we have only enumerated those Asiatic languages of which we have some knowledge in Europe, and even alphabets, grammars, or other books capable of giving us some information concerning them. But in those vast regions and the adjacent islands, there are doubtless other languages and dialects, of which no distinct account has yet been obtained.

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[1] See Charpentier, *Eléments de la Langue Russe.*

African Languages. The principal languages of Africa are, the modern Egyptian, the language of the kingdom of Fez, the Moroccan, and the jargons of those savage nations who inhabit the central regions of that great continent. The people on the coast of Barbary speak a corrupt dialect of the Arabic. To these may be added the Chilhic language, otherwise called *Tamazeght;* the Nigritian, and that of Guinea; the Abyssinian, and the language of the Hottentots and Caffres.

(o. o. o. o.)

American Languages. The number of languages which distinguish the different native tribes of America, appears to be still more considerable in that continent than in Africa, where, according to the researches of Seetzen and Vater, there are above a hundred and forty. In this respect, America resembles the Caucasus, Italy previous to the conquest of the Romans, and Asia Minor, when that country contained the Cilicians of Semitic origin, the Phrygians of Thracian or Gothic extraction, the Lydians, and the Celts. Many circumstances contributed to produce the amazing variety of American dialects, but the principal undoubtedly was the absence of all communication between the different native tribes, occasioned partly by their own condition of life, and partly by the nature and configuration of the country they inhabited. But when it is asserted that several hundreds of languages are found in a continent the whole population of which is scarcely equal to that of France, it should be kept in view that we regard as different all those languages which bear the same affinity to each other, not as the German and Dutch, or the Italian and Spanish, but as the Danish and the German, the Chaldaic and the Arabic, the Greek and the Latin. It is a great mistake to suppose, as some have done, that these languages are all separate and independent, having no points of relation, analogy, or resemblance. In proportion as we penetrate into the labyrinth of the American idioms, we discover that several are susceptible of being classed by families; whilst a still greater number remain insulated like the Basque amongst the European, and the Japanese amongst Asiatic languages. This separation, however, may be only apparent; for it may be presumed that languages which appear to admit of no ethnographical classification, have some affinity, either with other languages which have for a long time been extinct, or with the idioms of nations which have never yet been visited by travellers. The greater number of the American languages, even such as exhibit the same differences from each other as the languages of Teutonic origin, the Celtic, and the Sclavonian, bear a certain analogy in the whole of their organization or structure; particularly in the complication of their grammatical forms, in the modification of the verb according to the nature of its syntactical construction, and in the number of particles employed additively either as affixes or as suffixes. Such an uniform tendency of idioms betrays, if not a community of origin, at least a great analogy in the intellectual dispositions of the American tribes from the Arctic regions to the Straits of Magelhaens.[1]

Investigations made with scrupulous exactness, by following a method which had not previously been employed in etymological pursuits have proved that there are but few words which are common in the vocabularies of the New and Old World. In eighty-three American languages, examined by Barton and Vater, one hundred and seventy words have been found, the roots of which appear to be the same; and that this analogy is not accidental may be inferred from the circumstance that it does not rest merely on imitative harmony, or that conformity in the organs which produces almost a perfect identity in the first sounds articulated by children. Of the hundred and seventy words which are common to the two continents, three-fifths resemble the Mantchoo, the Tongouss, the Mongul, and the Samoyed; and two-fifths resemble the Celtic and Finnish, the Coptic and the Congo languages. These words have been discovered by comparing the whole of the American languages with the whole of those of the Old World; for as yet we are not acquainted with any American idiom, which appears to have an exclusive correspondence with any of the Asiatic, African, or European languages. Much has been said by some learned writers, respecting the pretended poverty of all the American languages, and the extreme imperfection of their numerical system; but, in the absence of well-authenticated facts, all such statements should be received with caution, being rather deductions from a preconceived theory, than the result of actual investigation. Besides, several idioms which now form the speech of barbarous nations, appear to be the wrecks of languages, once rich, flexible, and belonging to a far more cultivated state of society. Whether the primitive condition of the human race was rude and brutalised, or whether the savage hordes which still exist are descended from nations, whose intellectual faculties, and the languages which reflect them, were equally developed, is a question into which we cannot at present enter. We shall only observe, that the little we know of the history of the Americans, tends to prove that the tribes, whose migrations have been directed from the north to the south, whilst yet dwelling in the arctic regions, employed various idioms, which are now found under the torrid zone; and from this we may by analogy conclude, that the multiplication of languages is a very ancient phenomenon. Perhaps those which we call American belong no more to America than the Magyar or Hungarian, and the Tschoud or Finnish belongs to Europe. It is doubtless true that the comparison between the idioms of the two continents has hitherto led to no important conclusion. But we may nevertheless indulge the hope that this study will become more productive, when a greater number of materials shall have been accumulated to exercise the sagacity of the learned. At present many languages exist in America, and in central and eastern Asia, the mechanism of which is as much unknown to us as that of the Tyrhenian, the Oscan, the Umbrian, and the Sabine.

Conclusion. It was our original intention to conclude this article with some general remarks on the modern languages of Europe, particularly the French, the Italian, the Spanish, and the Portuguese, on the one hand, and on the German and English, on the other. But the length to which it has already extended, and the facility of access to works containing ample information respecting the genius and structure of these languages, render it inexpedient to enter into details which are more or less within the reach of almost every well-informed reader.

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[1] The natives of America may be divided into two great classes. To the first belong the Esquimaux of Greenland, Labrador, and Hudson's Bay, and the inhabitants of Behring's Straits, Alaska, and Prince William's Sound. The eastern and western branches of this family are united by close similarity of language, though separated by a distance of eight hundred leagues; and the inhabitants of the north-east of Asia are believed to be of the same stock. The second race is dispersed over the various regions of the continent, from the northern parts to the southern extremity. They are larger in size, more warlike, more taciturn, and also differ considerably from the northern class in the colour of their skin, which, according to Humboldt, has been but slightly affected, in either class, by climate or other external circumstances.

Philomathes || Philopœmen.

PHILOMATHES, a lover of learning or science.

PHILOMELA, in fabulous history, was the daughter of Pandion king of Athens, and the sister of Procne, who had married Tereus king of Thrace. Procne separated from Philomela, to whom she was much attached, and spent her time in great melancholy, until she prevailed upon her husband to go to Athens and bring her sister to Thrace. Tereus obeyed; but he had no sooner obtained Pandion's permission to conduct Philomela to Thrace, than he fell in love with her, and resolved to gratify his passion. He dismissed the guards whom the suspicions of Pandion had appointed to watch him; offered violence to Philomela; and afterwards cut out her tongue, that she might not disclose the indignities she had suffered from his barbarity. He confined her in a lonely castle; and having taken every precaution to prevent a discovery, he returned to Thrace, and told Procne that Philomela had died by the way, and that he had paid the last offices to her remains. At this sad intelligence Procne put on mourning for the loss of Philomela; but a year had scarcely elapsed before she was secretly informed that her sister was not dead. Philomela, in her captivity, described on a piece of tapestry her misfortunes and the brutality of Tereus, and privately conveyed it to Procne. The latter was about to celebrate the orgies of Bacchus when she received it, but she disguised her resentment; and as during these festivals she was permitted to rove about the country, she hastened to deliver her sister Philomela from her confinement, and concerted with the latter the best measures for punishing the cruelty of Tereus. She murdered her son Itylus, then in the sixth year of his age, and served him up as food to her husband during the festival. Tereus, in the midst of his repast, called for Itylus; but Procne immediately informed him that he was then feasting on his flesh, when Philomela, by throwing upon the table the head of Itylus, convinced the monarch of the cruelty of the scene. He drew his sword to punish Procne and Philomela; but whilst about to stab them to the heart, he was changed into a hoopoe, Philomela into a nightingale, Procne into a swallow, and Itylus into a pheasant. This tragedy happened at Daulis, in Phocis; but Pausanias and Strabo. who mention the whole of the story, are silent respecting the transformation; and the former observes, that Tereus, after this bloody repast, fled to Megara, where he laid violent hands on himself. The inhabitants of the place raised a monument to his memory, where they offered yearly sacrifices, and placed thereon small pebbles instead of barley. It was on this monument that the birds called hoopoes were first seen, and hence the fable of his metamorphosis. Procne and Philomela died of excessive grief and melancholy; and as the voice of the nightingale and the swallow is peculiarly plaintive and mournful, the poets have embellished the fable by supposing that the two unfortunate sisters were changed into these birds.

PHILOPŒMEN, a celebrated general of the Achæan league, was born in Megalopolis, a city of Arcadia, in Peloponnesus, and from his very infancy discovered a strong inclination to the profession of arms. Having been nobly educated by Cassander of Mantinea, a man of great probity and uncommon abilities, he was no sooner able to bear arms than he entered amongst the troops which the city of Megalopolis sent to make incursions into Laconia, and in these inroads never failed to give some remarkable instance of his prudence and valour; but when there were no troops in the field, he used to employ his leisure in hunting and other manly exercises. When Cleomenes, king of Sparta, attacked Megalopolis, Philopœmen displayed equal courage and greatness of soul. He also signalized himself some time afterwards in the battle of Sellasia, where Antigonus gained a complete victory over Cleomenes. Antigonus, who had been an eye-witness of his prudent and intrepid behaviour, endeavoured to gain him over to his interest; but the patriotic Greek rejected all his offers, having an utter aversion to a court life, which he compared to that of a slave, conceiving a courtier to be only a slave of a better condition. As he could not live idle and inactive, he proceeded to the island of Crete, which was then engaged in war, and served as a volunteer, until he acquired a complete knowledge of the military art; for the inhabitants of that island were in those days accounted excellent warriors, and were scarcely ever at peace amongst themselves. Philopœmen, having served some years with the troops of the island, returned home, and upon his arrival was appointed general of the horse; a command in which he behaved so well, that the Achæan cavalry, heretofore of no reputation, became in a short time famous all over Greece. He was soon afterwards appointed general of the Achæan forces, and applied himself to re-establish military discipline amongst the troops of the republic, which he found in a very low condition, and universally despised by their neighbours. Aratus, indeed, was the first who raised the Achæan state to that pitch of power and glory to which it attained; but the success of his enterprise was not so much owing to his courage and intrepidity as to his prudence and politics. As he depended on the friendship of foreign princes, and their powerful succours, he neglected military discipline at home; but the instant Philopœmen was appointed commander-in-chief, he roused the courage of his countrymen, and laboured to put them into a condition to defend themselves without the assistance of foreign allies. With this view he made great improvements in the Achæan discipline, changing the manner of their exercise, as well as their arms, which were both very defective. For the space of eight months he had exercised his troops every day, making them perform every movement and evolution, and accustoming them to manage with dexterity their arms, when news reached him that Machanidas was advancing, at the head of a numerous army, to invade Achaia. He was glad of this opportunity to try how the troops had profited by his discipline; and accordingly, taking the field, he met the enemy in the territories of Mantinea, where a decisive battle was fought, in which the Achæans were completely victorious. On this occasion the Lacedæmonians lost above 8000 men, of whom 4000 were killed on the spot, and as many taken prisoners. The loss of the Achæans was very inconsiderable, and those who fell were mostly mercenaries. This happened about the year before Christ 204.

But what most contributed to raise the fame and the reputation of Philopœmen, was his uniting the powerful city of Lacedæmon to the Achæan commonwealth, by which means the Achæans were enabled to eclipse all the other states of Greece. In this transaction, which happened in the year 191, we cannot help noticing one circumstance, which, in our opinion, reflects greater lustre on Philopœmen than all his warlike exploits. The Lacedæmonians, overjoyed to find themselves delivered from the oppressions under which they had long groaned, ordered the palace and furniture of Nabis to be sold, and the sum thence accruing, to the amount of 120 talents, to be presented to Philopœmen, as a token of their gratitude; and deputies were appointed to carry the money, and desire Philopœmen, in the name of the senate, to accept of the present. But so great was the opinion which the Spartans entertained of his probity and disinterestedness, that no one could be found who would undertake to offer the present; and, struck with veneration and the fear of displeasing him, they all begged to be excused. At last, by a public decree, they obliged one Timolaus, who had formerly been his guest, to repair to Megalopolis, where Philopœmen then lived, and offer him this testimony of their regard. Timolaus, with great reluctance, set out for Megalopolis, where he was kindly received and entertained by Philopœmen. Here he had an opportunity of observing the strictness of his conduct, the greatness

Philosopher's Stone.

of his mind, the frugality of his life, and the regularity of his manners; all which struck him with such awe, that he durst not once mention the present he had come to offer, and, alleging some other pretence for his journey, he returned home with the money. The Lacedæmonians sent him again; but still he could not prevail on himself to mention the true cause of his journey. At last, being sent a third time, he ventured, with reluctance, to apprise Philopœmen of the offer he had to make in the name of the Lacedæmonians. Philopœmen heard him with great calmness; but the instant he had finished, the general set out with him for Sparta, where, after acknowledging his obligation to the Spartans, he advised them to lay out their money in reforming or purchasing those miscreants who divided the citizens, and set them at variance by means of their seditious discourses, that, being paid for their silence, they might not occasion so many distractions in the government. "It is much more advisable," said he, "to stop an enemy's mouth than a friend's; as for me, I shall always be your friend, and you shall reap the benefit of my friendship without expense."

About two years afterwards, the city of Messene withdrew itself from the Achæan league. Philopœmen attacked them, but was wounded, taken prisoner, and poisoned by the magistrates; and thus died one of the greatest heroes whom Greece or any other country had ever produced. He was no way inferior in valour, military knowledge, and virtue, to any of the boasted heroes of Rome. Had Achaia been nearer to an equality with Rome, he would have preserved his country from the yoke which the Roman republic imposed upon it. Both the Greek and Roman writers place him on a level with Hannibal and Scipio, who were his contemporaries, and died the same year. They allow him to have been not only one of the greatest commanders, but also one of the greatest statesmen, of his age. To his valour and prudence Achaia owed her glory, which upon his death began to decline; for after him there was none in that republic capable of opposing her enemies with the same steadiness and prudence. Philopœmen was therefore called the last of the Greeks, as Brutus was afterwards styled the last of the Romans. See the article Army.

PHILOSOPHER, a person versed in philosophy, or one who makes profession of, and applies himself to, the study of wisdom or real knowledge.

Philosopher's *Stone*, the great object of alchemy, a long-sought-for preparation, which, when found, was to transmute all the true mercurial part of metal into pure gold, better than any that is obtained from mines, or perfected by the refiner's art.

Some Greek writers belonging to the fourth and fifth centuries speak of this art as being then known; and towards the end of the thirteenth century, when the learning of the East had been imported by the Arabians, the same pretensions began to spread throughout Europe. It is supposed that this art, called *alchemy*, was of Egyptian origin; and that when the ancient Greek philosophers travelled into Egypt, they brought back some of the allegorical language of this Egyptian art, which, being ill understood, afterwards passed into their mythology. Alchemy was the earliest branch of chemistry, considered as a philosophical science. In the other parts of chemical knowledge, facts preceded reasoning or speculation; but in alchemy all was originally speculative.

The alchemists supposed that the general principles of metals consisted chiefly of two substances, which they called mercury and sulphur. They apprehended, that the pure mercurial, sulphureous, or other principles of which they imagined gold to be composed, were contained separately in other bodies; wherefore they endeavoured to collect these principles, and to concoct and incorporate them by long digestions; and by thus conjoining the principles of gold, they expected that gold would be produced. But the alchemists pretended to a product of a higher order, *called the elixir, the medicine for metals, the tincture, the philosopher's stone*, which, by being projected on a large quantity of any of the inferior metals in fusion, should change them into fine gold; or which, being laid on a plate of silver, copper, or iron, and moderately heated, should sink into the metal, and change into gold all the parts to which it was applied; or which, on being properly heated with pure gold, should change the gold into a substance of the same nature and virtue with itself, so as to be susceptible of perpetual multiplication, and, by continued coction, to have its power more and more exalted, so as to be able to transmute greater and greater quantities of the inferior metals, according to its different degrees of perfection.

The alchemists attempted to arrive at the making of gold by three different methods. The first was by separation; for every metal yet known was supposed to contain some quantity of gold, though, in most, the quantity was believed to be so little as not to defray the expense of disengaging it. The second was by maturation. The alchemists considered mercury as the basis and matter of all metals; they thought that quicksilver purged from all heterogeneous bodies would be much heavier, denser, and simpler, than the native quicksilver, and that by subtilizing, purifying, and digesting it with much labour, and by long operations, it was possible to convert it into pure gold. This method was only for mercury. With respect to the other metals, it was ineffectual, because their matter was not pure mercury, but had other heterogeneous bodies adhering to it; and because the digestion, by which mercury is turned into gold, would not succeed in other metals, from their not having been long enough in the mines. Weight is the inimitable character of gold. But mercury, according to them, has always some impurities in it, which are lighter than mercury; and could these be purged away, which they thought not impossible, mercury would be as heavy as gold, and what was as heavy as gold was gold, or at least might very easily be made gold. The third method was by transmutation, or by turning all metals readily into pure gold, by melting them in the fire, and casting a little quantity of a certain preparation into the fused matter; upon which the fæces would be volatilized and burned, or carried off, and the rest of the mass would be turned into pure gold. That which was to work this change in the metals received the denomination of the *philosopher's stone.*

The following historical notices on this curious subject occur in Holt's Charaeters of the Kings and Queens of England. "The opinion," says he, "that one metallic or other foreign substance might be changed into another, was, it seems, at this time (in the reign of Henry VI. of England) propagated by certain chemists, whose observations on the surprising effects and alterations produced in certain substances by the force of heat carried their imaginations beyond what sound judgment might warrant; the first instance of which on record is in Rymer's *Fœdera* (vol. xi. p. 68), wherein Henry VI. grants a license to John Cobbe, freely to work in metals, he having, by philosophical art, found out a method of transmuting imperfect metals into perfect gold and silver. This pretended secret, known afterwards by the name of the *philosopher's stone* or *powder*, was encouraged by four licenses, granted to different projectors, during this reign, and at sundry times after during this century particularly, and in succeeding times all over Europe."

PHILOSOPHY.[1]

History.
Definition.

Philosophy is a word derived from the Greek, and literally signifies the *love of wisdom.* In its usual acceptation, however, it denotes a science, or collection of sciences, of which the universe is the object; and of the term thus employed many definitions have been given, differing from one another according to the different views of their several authors. By Pythagoras, philosophy is defined *ἐπιστημη των ὀντων*, the knowledge of things existing; by Cicero, after Plato, "scientia rerum divinarum et humanarum cum *causis*;" and by the illustrious Bacon, *interpretatio naturæ.* Whether any of these definitions be sufficiently precise, and at the same time sufficiently comprehensive, may perhaps be questioned; but if philosophy in its utmost extent be capable of being adequately defined, it is not here that the definition should be given. "Explanation," says an acute writer,[2] "is the first office of a teacher; definition, if it be good, is the last of the inquirer after truth; but explanation is one thing, and definition quite another." It may be proper, however, to observe, that the definition given by Cicero is better than that of Pythagoras, because the chief object of the philosopher is to ascertain the *causes* of things; and in this consists the difference between his studies and those of the natural historian, who merely enumerates phenomena, and arranges them into separate classes.

Objects of philosophy.

The principal objects of philosophy are, God, nature, and man. That part of it which treats of God is called Theology; that which treats of nature, Physics and Metaphysics; and that which treats of man, Logic and Ethics. That these are not separate and independent sciences, but, as Bacon expresses it,[3] branches from the same trunk, we shall endeavour to show, after we have, agreeably to our usual plan, given a short history of philosophy from the earliest ages to the present day.

To attempt to assign an origin to philosophy would be ridiculous; for every man endeavours to ascertain the causes of those changes which he observed in nature; and even children themselves are inquisitive after that which produces the sound of their drums and their rattles. Children, therefore, and the most illiterate vulgar, have in all ages been philosophers. But the first people amongst whom philosophy was cultivated as a profession was probably the Chaldeans. We certainly read of none earlier; for although we have more authentic accounts of the Hebrews than of any other nation of remote antiquity, and have reason to believe that no people was civilized before them, yet the peculiar circumstances in which they were placed rendered all philosophical investigation to them useless, and even tended to suppress the very spirit of inquiry. The Egyptians indeed pretended to be the first of nations, and to have spread the blessings of religion and the light of science amongst every other people; but, from the earliest records now extant, there is reason to believe that the Chaldeans were a civilized and powerful nation before the Egyptian monarchy was founded.

Histor

Philosop of the Ch deans.

Of the Chaldean philosophy much has been said, but very little is known. Astronomy seems to have been their favourite study; and at the era of Alexander's conquest of their country, they boasted that their ancestors had continued their astronomical observations throughout a period of 470,000 years. Extravagant claims to antiquity have been common in all nations.[4] Calisthenes, who attended the Macedonian conqueror, was requested by Aristotle to inform himself concerning the origin of science in Chaldea; and upon examining into the grounds of this report, he found that their observations reached no farther backwards than 1903, or 2234 years before the Christian era. Even this is a remoter antiquity than Ptolemy allows to their science; for he mentions no Chaldean observations prior to the era of Nabonassar, or 747 years before Christ. That they cultivated something which they called philosophy at a much earlier period than this, cannot be questioned; for Aristotle,[5] on the credit of the most ancient records, speaks of the Chaldean magi as prior to the Egyptian priests, who were certainly men of learning before the time of Moses. For any other science than that of the stars we do not read that the Chaldeans were famous; and this seems to have been cultivated by them merely as the foundation of judicial astrology. Persuading the multitude that all human affairs are influenced by the stars, and professing to be acquainted with the nature and laws of this influence, their wise men pretended to calculate nativities, and to predict good and bad fortune.[6] This was the source of idolatry and various superstitions; and whilst the Chaldeans were given up to such puerilities, true science could not be much indebted to their labours. If any credit be due to Plutarch and Vitruvius, who quote Berosus, it was the opinion of the Chaldean wise men that an eclipse of the moon happens when that part of its body which is destitute of fire is turned towards the earth. Their cosmogony, as given by Berosus, and preserved by Syncellus, seems to be this, that all things in the beginning consisted of darkness and water; that a divine power, dividing this humid mass, formed the world; and that the human mind is an emanation from the divine nature.[7]

The large tract of country which comprehended the empires of Assyria and Chaldea was the first peopled region on earth. From that country, therefore, the rudiments of science must have been propagated in every direction throughout the rest of the world; but what particular people made the earliest figure, after the Chaldeans, in the history of philosophy, cannot be certainly known. The claim of the Egyptians is probably best founded; but as their science was the immediate source of that of the Greeks, we shall defer what we have to say of it, on account of the connection between the parent and the offspring, and turn our attention from Chaldean to Indian philosophy, as it has been cultivated from a very early period by the Brahmins and Gymnosophists. We pass over Persia, because we know not of any science peculiar to that kingdom except the doctrines of the magi, which were religious rather than philosophical.

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[1] This article, which was written by the late Professor Robison for the *third* edition of the present work, has, after some slight alterations, been retained, as well on account of the frequent references to it from the article Physics, contributed by the same distinguished author, as on account of the elaborate and somewhat peculiar view which it takes of Lord Bacon's philosophy. On this latter subject, however, the reader will do well to turn to the invaluable commentary upon the *Novum Organum*, contained in the *Second* Dissertation prefixed to the present edition.

[2] Tatham's Chart and Scale of Truth, vol. i. p. 8.

[3] Convenit igitur partiri philosophiam in doctrinas tres; *doctrinam de numine, doctrinam de natura, doctrinam de homine.* Quoniam autem partitiones *scientiarum* non sunt lineis diversis similes, quæ coeunt ad unum angulum, sed potius ramis arborum, qui conjunguntur in uno trunco, qui etiam truncus ad spatium nonnullum integer est et continuus, antequam se partiatur in ramos. (*De Aug. Scient.* lib. iii. cap. 1.)

[4] This claim of the Babylonians is thus rejected with contempt by Cicero: "Contemnamus Babylonios, et eos, qui e Caucaso cœli signa servantes, numeris, et motibus, stellarum cursus persequuntur; condemnemus, inquam, hos aut *stultitiæ*, aut *vanitatis*, aut *imprudentiæ*, qui 470 millia annorum, ut ipsi dicunt, monumentis comprehensa continent, et mentiri judicemus, nec *sæculorum reliquorum judicium*, quod de ipsis futurum sit, *pertimescere.*" (*De Divinatione*, lib. i. § 19.)

[5] Apud Laertium, lib. i. § 8.

[6] Sextus Emp. *ad Math.*, lib. iv. § 2; Strabo, lib. c.; Cic. *de Div.* lib. i. § 1.

[7] Enfield's *Hist. Phil.* vol. i.

Indian philosophy.

From whatever quarter India received its wisdom, we are certain that its philosophers were held in high repute at a period of very remote antiquity, since they were visited by Pythagoras and other sages of ancient Greece, who travelled in pursuit of knowledge. Yet they seem to have been in that early age, as well as at present, more distinguished for the severity of their manners than for the acquisition of science; and, as Dr Enfield observes, they appear to have more resembled modern monks than ancient philosophers. The Brahmans or Brahmins, it is well known, are all of one tribe; and the most learned of them are in their own language called Pundits. The Greek writers, however, mention a society called *Samanæans*, who, voluntarily devoting themselves to the study of divine wisdom, gave up all private property, committing their children to the care of the state, and their wives to the protection of their relations. This society was supported at the public expense; and its members spent their time in contemplation, in conversation on divine subjects, or in acts of religion.

The philosophy of the Indians has indeed from the beginning been engrafted upon their religious dogmas, and seems to be a compound of fanatical metaphysics and extravagant superstition, without the smallest seasoning of rational physics. Very unlike the philosophers of modern Europe, of whom a great part labour to exclude the agency of mind from the universe, the Pundits of Hindustan allow no powers whatever to matter, but introduce the Supreme Being as the immediate cause of every effect, however trivial. "Brahm, *the Spirit of God*," says one of their most revered Brahmins, "is absorbed in self-contemplation. The same is the mighty lord, who is present in every part of space, whose omnipresence, as expressed in the Reig Beid or Rigveda, I shall now explain. Brahm is one, and to him there is no second; such is truly Brahm. His omniscience is self-inspired or self-intelligent, and its comprehension includes every possible species. To illustrate this as far as I am able, the most comprehensive of all comprehensive faculties is omniscience; and being self-inspired, it is subject to none of the accidents of mortality, conception, birth, growth, decay, or death; neither is it subject to passion or vice. To it the three distinctions of time, past, present, and future, are not. To it the three modes of being are not.[1] It is separated from the universe, and independent of all. This omniscience is named Brahm. By this omniscient Spirit the operations of God are enlivened. By this Spirit also the twenty-four powers[2] of nature are animated. How is this? As the eye by the sun, as the pot by the fire, as iron by the magnet,[3] as variety of imitations by the mimic, as fire by the fuel, as the shadow by the man, as dust by the wind, as the arrow by the spring of the bow, and as the shade by the tree, so by this Spirit the world is endued with the powers of intellect, the powers of the will, and the powers of action. Hence, if it emanates from the heart by the channel of the ear, it causes the perception of sounds; if it emanates from the heart by the channel of the skin, it causes the perception of touch; if it emanates from the heart by the channel of the eye, it causes the perception of visible objects; if it emanates from the heart by the channel of the tongue, it causes the perception of taste; if it emanates from the heart by the channel of the nose, it causes the perception of smell. This also invigorating the five members of action, and invigorating the five members of perception, and invigorating the five elements, and invigorating the five senses, and invigorating the three dispositions of the mind, causes the creation or the annihilation of the universe, whilst itself beholds every thing as an indifferent spectator."[4]

From this passage it is plain that all the motions in the universe, and all the perceptions of man, are, according to the Brahmins, caused by the immediate agency of the Spirit of God, which seems to be here considered as the soul of the world. But it appears, from some papers in the Asiatic Researches, that the most profound of these oriental philosophers, and even the authors of their sacred books, believe not in the existence of matter as a separate substance, but hold an opinion respecting it very similar to that of the celebrated Berkeley. The Vedants, says Sir William Jones, unable to form a distinct idea of brute matter independent of mind, or to conceive that the work of Supreme Goodness was left a moment to itself, imagine that the Deity is ever present to his work, and constantly supports a series of perceptions, which in one sense they call *illusory*, though they cannot but admit the reality of all created forms, as far as the happiness of creatures can be affected by them. This is the very immaterialism of Berkeley; and in proof that it is the genuine doctrine of the Brahmins, the learned president quotes the *Bhágavat*, which is believed to have been pronounced by the Supreme Being, and in which is the following sentence: "Except the *first cause*, whatever may appear, and may not appear, in the mind, know that to be the mind's *Máyá*, or delusion, as light, as darkness."

We have shown elsewhere (see METAPHYSICS), that the metaphysical doctrines of the Brahmins respecting the human soul differ not from those of Pythagoras and Plato; and that they believe it to be an emanation from the great soul of the world, which, after many transmigrations, will be finally absorbed in its parent substance. In proof of their believing in the metempsychosis, Mr Halhed gives us the following translation of what, he says, is a beautiful stanza in the Gēētā: "As, throwing aside his old clothes, a man puts on others that are new; so our lives, quitting the old, go to other newer animals."

Physics and astronomy of the Brahmins.

From the Brahmins believing in the soul of the world not only as the sole agent, but as the immediate cause of every motion in nature, we can hardly suppose them to have made any great progress in that science which in Europe is cultivated under the name of Physics. They have no inducement to investigate the laws of nature, because, according to the first principles of their philosophy, which, together with their religion, they believe to have been revealed from heaven, every phenomenon, however regular, or however anomalous, is produced by the voluntary act of an intelligent mind. Yet if they were acquainted with the use of fire-arms four thousand years ago, as Mr Halhed seems to

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[1] To be awake, to sleep, and to be absorbed in a state of unconsciousness, that is, in a kind of trance.

[2] The twenty-four powers of nature, according to the Brahmins, are the five elements, fire, air, earth, water, and akash (a kind of subtile æther); the five members of action, the hand, foot, tongue, anus, and male organ of generation; the five organs of perception, the ear, eye, nose, mouth, and skin; the five senses, which they distinguish from the organs of sensation; the three dispositions of the mind, desire, passion, and tranquillity; and the power of consciousness.

[3] If the work from which this extract is quoted be of as great antiquity as Mr Halhed supposes, the Brahmins must have been acquainted with the phenomena of magnetism at a much earlier period than any other philosophers of whom history makes mention.

[4] Preliminary Dissertation to Halhed's Gentoo Laws.

History.

believe, he who made that discovery must have had a very considerable knowledge of the powers of nature; for though gunpowder may have been discovered by accident in the East, as it certainly was in the West many ages afterwards, it is difficult to conceive how mere accident could have led any man to the invention of a gun. In astronomy, geometry, and chronology, too, they appear to have made some proficiency at a very early period. Their chronology and astronomy are indeed full of those extravagant fictions which seem to be essential to all their systems; but their calculation of eclipses, and their computations of time, are conducted upon scientific principles.

"It is sufficiently known," says Mr Davis,[1] "that the Hindu division of the ecliptic into signs, degrees, &c. is the same as ours; that their astronomical year is sidereal, or containing that space of time in which the sun, departing from a star, returns to the same; that it commences on the instant of his entering the sign Aries, or rather the Hindu constellation Mésha; that each astronomical month contains as many even days and fractional parts as he stays in each sign; and that the civil differs from the astronomical account of time only in rejecting those fractions, and beginning the year and month at sunrise, instead of the intermediate instant of the artificial day or night. Hence arises the unequal portion of time assigned to each month, dependent on the situation of the sun's apsis, and the distance of the vernal equinoctial colure from the beginning of Mésha in the Hindu sphere; and by these means they avoid those errors which Europeans, from a different method of adjusting their calendar by intercalary days, have been subject to."

Mr Davis observes, that an explanation of these matters would have led him beyond his purpose, which was only to give a general account of the method by which the Hindus compute eclipses, and to show that the science of astronomy is as well known amongst them now as ever it was amongst their ancestors. This he does very completely; but in the present short historical sketch we can neither copy nor abridge his memoir. Suffice it to say, that he has shown the practical part of the Hindu astronomy to be founded on mathematical principles; and that the learned Pundits appear to have truer notions of the form of the earth and the economy of the universe than those which are ascribed to their countrymen in general.

The same writer likewise shows, that the prodigious duration which the Hindus attribute to the world, is the result of a scientific calculation, founded indeed upon very whimsical principles. "It has been common with astronomers to fix on some epoch, from which, as from a radix, to compute the planetary motions; and the ancient Hindus chose that point of time counted back, when, according to their motions as they had determined them, they must have been in conjunction in the beginning of Mésha or Aries, and coeval with which circumstance they supposed the creation. This, as it concerned the planets only, would have produced a moderate term of years compared with the enormous antiquity that will be hereafter stated; but having discovered a slow motion of the nodes and apsides also, and taken it into computation, they found it would require a length of time corresponding with 1,955,884,890 years, now expired, when they were so situated, and 2,364,115,110 years more before they would return to the same situation again, forming together the grand anomalistick period denominated a *Calpa*, and fancifully assigned as the day of Brahma."

Strange notions of the universe.

But although the mathematical part of the astronomy of the Pundits is undoubtedly respectable, their physical notions of the universe are in the highest degree ridiculous and extravagant. In the Vedas and Puranas, writings of which no devout Hindu can dispute the divine authority, eclipses are said to be occasioned by the intervention of the monster *Rahu*, and the earth to be supported by a series of animals. "They suppose," says Mr Halhed, "that there are fourteen spheres, seven below and six above the earth. The seven inferior worlds are said to be altogether inhabited by an infinite variety of serpents, described in every monstrous figure that the imagination can suggest. The first sphere above the earth is the immediate vault of the visible heavens, in which the sun, moon, and stars are placed. The second is the first paradise, and general receptacle of those who merit a removal from the lower earth. The third and fourth are inhabited by the souls of those men who, by the practice of virtue and dint of prayer, have acquired an extraordinary degree of sanctity. The fifth is the reward of those who have all their lives performed some wonderful act of penance and mortification, or who have died martyrs for their religion. The highest sphere is the residence of Brahma and his particular favourites, such as those men who have never uttered a falsehood during their whole lives, and those women who have voluntarily burned themselves with their husbands. All these are absorbed in the divine essence."

Ethic the Hi

On ethics, the Hindus have nothing that can be called philosophy. Their duties, moral, civil, and religious, are all laid down in their Vedas and Shasters, and enjoined by what they believe to be divine authority, which supersedes all reasoning concerning their fitness or utility. The business of their Pundits is to interpret these books, which are extremely ancient, and written in a language that has long been unintelligible to every other order of men; but no Pundit will alter the text, however impossible to be reconciled to principles established in his own practice of astronomy. On such occasions, the usual apology for their sacred books is, that "such things may have been so formerly, and may be so still; but that for astronomical purposes astronomical rules must be followed."[2] The great duties of morality have been prescribed in every religious code; and they are not overlooked in that of the Hindus, although the highest merit that a Brahmin can have consists in voluntary acts of abstinence and mortification, and in contempt of death.

Philo of the bians Chine

Of the ancient philosophy of the Arabians and Chinese nothing certain can be said; and the narrow limits of such an abstract as this do not admit of our mentioning the conjectures of the learned, which contradict each other, and are all equally groundless. There is indeed sufficient evidence that both nations were at a very early period observers of the stars, and that the Chinese had even a theory by which they foretold eclipses; but there is reason to believe that the Arabians, like other people in their circumstances, were nothing more than judicial astrologers, who possessed not the smallest portion of astronomical science. Pliny makes mention of their magi, whilst later writers tell us that they were famous for their ingenuity in solving enigmatical questions, and for their skill in the arts of divination. But the authors of Greece are silent concerning their philosophy; and there is not an Arabian book of greater antiquity than the Koran extant.

Early ence Phœ cians.

Leaving therefore regions so barren of information, let us pass to the Phœnicians, whose commercial celebrity has induced many learned men to allow them great credit for early science. If it be true, as seems highly probable, that the ships of this nation had doubled the Cape and almost encompassed the peninsula of Africa long before the era of Solomon, we cannot doubt that the Phœnicians had made great proficiency in the art of navigation and in the science of astronomy at a period of very remote antiquity. Nor were these the only sciences cultivated by that ancient people. The learned Cudworth has, in our opinion, sufficiently proved that Moschus or Mochus, a Phœnician, who, according to Strabo, flourished before the Trojan war, was the author of the atomic philosophy afterwards adopted by Leucippus, Democritus, and others, amongst the Greeks; and that it was with some of the successors of this sage that, as Jamblichus tells us, Pythagoras conversed at Sidon, and from them received his doctrine of *monads*. Another proof of the early progress of the Phœnicians in philosophy may be found in the fragments of their historian Sanchoniathon, which have been preserved by Eusebius.[1] We are indeed aware that men of great celebrity have called in question the authenticity of those fragments, and even the very existence of such a writer as Sanchoniathon; but for this scepticism we can discover no solid foundation. His history may have been interpolated in some places by the translator Philo-Byblius; but Porphyry, Eusebius, and Theodoret, speak of it as a work of undoubted credit, and affirm that its author flourished before the Trojan war. Now this ancient writer teaches, that, according to the wise men of his country, all things arose at first from the necessary agency of an active principle upon a passive chaotic mass, which he calls *mot.* This chaos, Cudworth thinks, was the same with the elementary water of Thales, who was also of Phœnician extraction; but Mosheim justly observes that it was rather dark air, since Philo translates it ἀεϱα ζοφωδη. Be this as it may, nothing can be more evident than that the Phœnicians must have made some progress in what must surely be considered as philosophy, however false, as early as the era of Sanchoniathon; for speculations concerning the origin of the world never occur to untaught barbarians. Besides Mochus and Sanchoniathon, Cadmus, who introduced letters into Greece, may undoubtedly be reckoned amongst the Phœnician philosophers; for though it is not pretended that the alphabet was of his invention, and though it is by no means certain that the Greeks, at the time of his arrival amongst them, were wholly destitute of alphabetic characters; yet the man who could prevail with illiterate savages to adopt the use of strange characters, must have been a great master of the science of human nature. Several other Phœnician philosophers are mentioned by Strabo; but as they flourished at a later period, and philosophized after the systematic mode of the Greeks, they do not fall properly under our notice. We pass on therefore to the philosophy of Egypt.

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[1] Asiatic Researches, vol. ii.

[2] Davis's Memoir, in the Asiatic Researches, vol. ii.

tian sophy.

It has already been observed that the Egyptians boasted of being the first of nations, and the authors of all the science which in separate rays illuminated the rest of the world. But though this claim was undoubtedly ill founded, their high antiquity and early progress in the arts of civil life cannot be controverted. The Greeks with one voice confess that all their learning and wisdom came from Egypt, either imported immediately by their own philosophers, or brought through Phœnicia by the sages of the East; and we know, from higher authority than the histories of Greece, that at a period so remote as the birth of Moses the wisdom of the Egyptians was proverbially famous. Yet the history of Egyptian learning and philosophy, although men of the first eminence, both ancient and modern, have bestowed much pains in attempts to elucidate it, still remains involved in clouds of uncertainty. That they had some knowledge of physiology, arithmetic, geometry, and astronomy, are facts which cannot be questioned; but there is reason to believe that even these sciences were in Egypt pushed no farther than to the uses of life. That they believed in the existence of incorporeal substances is certain; because Herodotus assures us that they were the first assertors of the immortality, pre-existence, and transmigration of human souls, which they could not have been without holding those souls to be at least incorporeal, if not immaterial.

The founder of Egyptian learning is generally acknowledged to have been Thoth, Thent, or Taaut, called by the Greeks Hermes, and by the Romans Mercury; but of this personage very little is known. Diodorus Siculus says that he was chief minister to Osiris, and that he improved language, invented letters, instituted religious rites, and taught astronomy, music, and other arts. The same thing is affirmed by Sanchoniathon, whose antiquity has already been mentioned; by Manetho, an Egyptian priest, who flourished during the reign of Ptolemy Philadelphus; and by Plato, whose authority, as he resided long in Egypt, and was himself an eminent philosopher, is perhaps more to be depended upon than that of the other two. In the Philebus we are told that Thoth was the inventor of letters; and lest we should suppose that by these letters nothing more is meant than picture-writing or symbolical hieroglyphics, it is added, that he distinguished between vowels and consonants, determining the number of each. The same philosopher, in his Phædrus, attributes to Thoth the invention of arithmetic, geometry, astronomy, and hieroglyphical learning; and subjoins a disputation said to have been held between him and Thamus, then king of Egypt, concerning the advantage and disadvantage of his newly-invented letters. Thoth boasted that the invention, by aiding memory, would greatly contribute to the progress of science; whilst the monarch contended that it would enervate men's natural faculties, by making them trust to written characters, without exerting the powers of their own minds.

All this, if real, must have happened before the era of Moses; and since it is almost certain that alphabetical characters were in use prior to the exod of the Israelites from Egypt, we may as well allow the invention to Thoth, as give it to an earlier author of unknown name. That arithmetic, geometry, and astronomy, were cultivated in Egypt from the most remote antiquity, is affirmed by all the ancients, and rendered in the highest degree probable by the situation of the country. The first elements of astronomy have certainly been discovered by various nations, whose habits of life led them to the frequent observation of the heavens; and it is observed by Cicero, that the Egyptians and Babylonians, dwelling in open plains, where nothing intercepted the view of the heavenly bodies, naturally devoted themselves to the study of that science. The annual overflowing of the Nile, which broke up the boundaries of their land, would lay the Egyptians under the necessity of adopting some method of settling those boundaries anew; and necessity we know to be the parent of invention. Hence their early acquaintance with practical geometry cannot well be doubted. Their custom of embalming their dead, and the perfection to which they carried that art,[2] shows infallibly their knowledge of the properties of natural substances, and gives some reason to believe that they were not altogether strangers to anatomy; but if we allow them to have been at this early period anatomists acquainted with the power of drugs, we can hardly refuse them some skill in the art of physic, which they themselves traced up to their gods and demigods, to Serapis, Isis, and her son Horus or Apollo.

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[1] *Præparatio Evangelii.*

[2] It is true that the dissection of some mummies has lessened the high opinion long entertained of the skill of the ancient Egyptians in the art of embalming; yet it must be granted that their knowledge of antiseptic drugs was great, since it is now certainly known, even from these dissections, that by means of such drugs they contrived to preserve rags of cloth from corruption for upwards of three thousand years.

The art of alchemy has been said to have been known by the ancient Egyptians; and, from the author of the Egyptian philosophy, it has been called the Hermetic art. But although this is unquestionably a fiction, there is evidence that they were possessed of one art which is even yet a desideratum in the practice of chemistry. "Moses," we are told,[1] "took the golden calf which his brother had made for idolatrous purposes, and *burnt it in the fire*, and *ground it to powder*, and strewed it on the water, and made the children of Israel drink of it." Had this fact been related by Herodotus or Diodorus Siculus, it would have been deemed sufficient evidence that the Egyptians were even at that early period no strangers to the art of chemistry; and surely the evidence should not be the worse for coming from the pen of the Hebrew lawgiver, who was himself educated in the court of Egypt.

Their knowledge of the solar system.

But although it is thus evident that the rudiments of almost every useful science were known in Egypt from the remotest antiquity, it does not appear that any of them was carried to a great degree of perfection, unless perhaps chemistry alone must be excepted. One would think that no science could have been more indispensably requisite to them than geometry; and yet, though Pythagoras is said to have spent twenty-two years in Egypt studying that science and astronomy, he himself discovered[2] the famous forty-seventh proposition of Euclid's first book after his return to Samos. This, although a very useful, is yet a simple theorem; and since it was not reached by the Egyptian geometry, we cannot suppose that the people of Egypt had then advanced far in such speculations. The same conclusion must be drawn with respect to astronomy; for Thales is said to have been the first who calculated an eclipse of the sun, and we nowhere read that the Egyptians pretended to dispute that honour with him. To this it may be replied, that Pythagoras was in Egypt undoubtedly taught the true constitution of the solar system, and, what is more extraordinary, the doctrine of comets in particular, and of their revolutions, like the other planets, round the sun.[3] We grant that he was taught all this; but it was not scientifically, but dogmatically, as facts which the priests had received by tradition from their early ancestors, and of which they had never questioned the truth nor inquired into the reasons. Of this we need no better proof than that the Pythagorean system of the sun was totally neglected by the Greeks as soon as they began to frame hypotheses and to speculate in philosophy.[4]

But it may appear strange, and certainly is so, that the Egyptian priests, in the days of Pythagoras, should have preserved so great a discovery of their ancestors, and at the same time have totally forgotten the principles and reasoning which led to a conclusion apparently contrary to the evidence of sense. This is a difficulty which we pretend not to remove, although the fact which involves it seems to be beyond the reach of controversy. Perhaps the following observations may throw upon it a feeble light. According to Manetho, the written monuments of the first Thoth were lost or neglected in certain civil revolutions or natural calamities which befell the kingdom of Egypt. After many ages great part of them were recovered by an ingenious interpretation of the symbols which he had inscribed upon ancient columns; and the man who made this interpretation was called the second Thoth, or Hermes Trismegistus. But thrice illustrious as this personage was, it is at least possible that he may have been much inferior to the former Hermes, and have read his writings and transcribed his conclusions without being able to comprehend the principles or reasoning which led to these conclusions. Any man who understands Latin might translate into his own tongue the conclusions of Newton; but much more would be requisite to make him comprehend the demonstrations of his sublime geometry. By what mode of reasoning the first Hermes was led to the true idea of the solar system, or whether it was by reasoning at all, cannot now be known; but it seems very evident, that when the intercourse between the Egyptains and Greeks first commenced, the wisdom of the former people consisted chiefly in the science of legislation and civil policy, and that the philosopher, the divine, the legislator, and the poet, were all united in the same person. Their cosmogony (for all the ancients who pretended to science framed cosmogonies) differed little from that of the Phœnicians already mentioned. They held that the world was produced from chaos by the energy of an intelligent principle; and they likewise conceived that there is in nature a continual tendency towards dissolution. In Plato's *Timæus*, an Egyptian priest is introduced describing the destruction of the world, and asserting that this will be effected by means of water and fire. They conceived that the universe undergoes a periodical conflagration; after which all things are restored to their original form, to pass again through a similar succession of changes.

Their ral scie

"Of preceptive doctrine the Egyptians had two kinds, the one sacred, the other vulgar. The former, which respected the ceremonies of religion and the duties of the priests, was doubtless written in the sacred books of Hermes, but was too carefully concealed to pass down to posterity. The latter consisted of maxims and rules of virtue, prudence, or policy. Diodorus Siculus relates many particulars concerning the laws, customs, and manners of the Egyptians; whence it appears that superstition mingled with and corrupted their notions of morals. It is in vain to look for accurate principles of ethics among an ignorant and superstitious people. And that the ancient Egyptians merited this character is sufficiently evident from this single circumstance, that they suffered themselves to be deceived by impostors, particularly by the professors of the fanciful art of astrology; concerning whom Sextus Empiricus justly remarks, that they have done much mischief in the world, by enslaving men to superstition, which will not suffer them to follow the dictates of right reason."

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[1] Exodus, xxii. 20.

[2] This discovery he claimed; and his claim was admitted by the Greek writers, without having been directly controverted since. An excellent mathematician, however, has shown that the equality between the square of the hypothenuse of a right-angled triangle, and the sum of the squares on the other two sides, was known to the astronomers of India at a period long prior to that of Pythagoras. Notwithstanding this, it is certainly possible that the sage of Samos may have made the discovery himself, though we think the contrary much more probable; for we agree with the able writer already mentioned, that Pythagoras, who is generally believed to have conversed with Indian Brahmins as well as Egyptian priests, may have derived from them some of the solid as well as the visionary speculations with which he delighted to instruct or amuse his disciples. See Transactions of the Royal Society of Edinburgh, vol. ii.

[3] This is recorded by Aristotle and Plutarch, and thus expressed by Ammianus Marcellinus: "Stellas quasdam, *ceteris similes*, quarum *ortus orbitusque*, quibus sint temporibus præstituti humanis mentibus ignorari (lib. xxv. cap. 10).

[4] *Fixas* in supremis mundi partibus immotas persistere, et planetas his inferiores circa solem revolvi, terram pariter moveri cursu annuo, diurno vero circa axem propriam, et solem ceu focum universi in omnium centro quiescere, antiquissima fuit philosophantium sententia. Ab Ægyptiis autem astrorum antiquissimis observationibus propagatam esse hanc sententiam verisimile est. Et etiam ab illis et a gentibus conterminis ad Græcos, gentem magis philologicam quam philosophicam, philosophia omnis antiquior juxta et senior manasse videtur. Subinde docuerunt Anaxagoras, Democritus, et alii nonnulli, terram in centro mundi immotam stare, et astra omnia in occasum, aliqua celerius, alia tardius moveri, idque in spatiis liberrimis. Namque orbes solidi postea ab Eudoxo, Calippo, Aristotele, introducti sunt; declinante indies philosophia primitus introducta, et novis Græcorum commentis paulatim prævalentibus. *Quibus vinculis* ANTIQUI planetas in spatiis liberis retineri, deque cursu rectilineo perpetuo retractas in orbem regulariter agi docuere, non constat. (Newton *de Mundi Systemate.*)

From Egypt and Phœnicia philosophy passed into Greece, where it was long taught without system, as in the countries from which it was derived. Phoroneus, Cecrops, Cadmus, and Orpheus, were amongst the earliest instructors of the Greeks; and they inculcated Egyptian and Phœnician doctrines in detached maxims, and enforced them, not by strength of argument, but by the authority of tradition. Their cosmogonies were wholly Phœnician or Egyptian disguised under Grecian names; and they taught a future state of rewards and punishments. The planets and the moon Orpheus conceived to be habitable worlds, and the stars to be fiery bodies like the sun; but he taught that they are all animated by divinities, an opinion which prevailed both in Egypt and in the East. It does not appear, however, that he gave any other proof of his doctrines than a confident assertion that they were derived from some god.

Hitherto we have seen philosophy in its state of infancy and childhood, consisting only of a collection of sententious maxims and traditionary opinions; but amongst the Greeks, an ingenious and penetrating people, it soon assumed the form of profound speculation and systematic reasoning. Two eminent philosophers arose nearly at the same period, who may be considered as the parents not only of Grecian science, but of almost all the science which was cultivated in Europe prior to the era of the great Lord Bacon. These were Thales and Pythagoras, of whom the former founded the Ionic school, and the latter the Italic; from which two sprung the various sects into which the Greek philosophers were afterwards divided. A bare enumeration of these sects is all that our limits will admit of; and we shall give it in the perspicuous language and just arrangement of Dr Enfield, referring our readers for a fuller account than we can give of their respective merits to his abridged translation of Brucker's history.

From the *Ionic School* sprung various others: 1. The Ionic sect proper, whose founder Thales had as his successors Anaximenes, Anaxagoras, Diogenes Apolloniates, and Archelaus. 2. The Socratic school, founded by Socrates, the principal of whose disciples were Xenophon, Æschines, Simon, Cebes, Aristippus, Phædo, Euclid, Plato, Antisthenes, Critias, and Alcibiades. 3. The Cyrenaic sect, of which Aristippus was the author; his followers were, his daughter Arete, Hegisias, Anicerris, Theodorus, and Bion. 4. The Megaric or Eristic sect, formed by Euclid of Megara; to whom succeeded Eubulides, Diodorus, and Stilpo, famous for their logical subtilty. 5. The Eliac or Eretriac school, raised by Phædo of Elis, who, although he closely adhered to the doctrine of Socrates, gave name to his school. His successors were Plistanus and Menedemus; the latter of whom, being a native of Eretria, transferred the school and name to his own country. 6. The Academic sect, of which Plato was the founder. After his death, many of his disciples deviating from his doctrine, the school was divided into the old, new, and middle academies. 7. The Peripatetic sect, founded by Aristotle, whose successors in the Lyceum were Theophrastus, Strato, Lycon, Aristo, Critolaus, and Diodorus. Amongst the Peripatetics, besides those who occupied the chair, were also Dicæarchus, Eudemus, and Demetrius Phalereus. 8. The Cynic sect, of which the author was Antisthenes, whom Diogenes, Onesicritus, Crates, Metrocles, Menippus, and Menedemus, succeeded. In the list of Cynic philosophers must also be reckoned Hipparchia, the wife of Crates. 9. The Stoic sect, of which Zeno was the founder. His successors in the porch were Persæus, Aristo of Chios, Herillus, Sphærus, Cleanthus, Chrysippus, Zeno of Tarsus, Diogenes the Babylonian, Antipater, Panætius, and Posidonius.

The Italic school.

Of the *Italic School* were, 1. The Italic sect proper, founded by Pythagoras, a disciple of Pherecydes. The followers of Pythagoras were Aristæus, Mnesarchus, Alcmæon, Ecphantus, Hippo, Empedocles, Epicharmus, Ocellus, Timæus, Archytas, Hippasus, Philolaus, and Eudoxus. 2. The Eleatic sect, of which Xenophanes was the author. His successors, Parmenides, Melissus, Zeno, belonged to the metaphysical class of this sect; Leucippus, Democritus, Protagoras, Diagoras, and Anaxarchus, to the physical. 3. The Heraclitean sect, which was founded by Heraclitus, and soon afterwards expired. Zeno and Hippocrates philosophized after the manner of Heraclitus, and other philosophers borrowed freely from his system. 4. The Epicurean sect, a branch of the Eleatic, had Epicurus for its author; and amongst his followers were Metrodorus, Polyænus, Hermachus, Polystratus, Basilides, and Protarchus. 5. The Pyrrhonic or Sceptical sect, the parent of which was Pyrrho. His doctrine was taught by Timon the Phliasian; and after some interval was continued by Ptolemy, a Cyrenean, and at Alexandria by Ænesidemus.

Of the peculiar doctrines of these sects, the reader will in this work find a short account either in the lives of their respective founders, or under the names of the sects themselves. We shall only observe at present, that although many of them were undoubtedly absurd, and many wicked, it would yet perhaps be going too far to say with some, that the philosophy of Greece became impious under Diagoras, vicious under Epicurus, hypocritical under Zeno, impudent under Diogenes, covetous under Demochares, voluptuous under Metrodorus, fantastical under Crates, scurrilous under Menippus, licentious under Pyrrho, and quarrelsome under Cleanthes. Of the truth of this heavy charge every reader must judge for himself. We are strongly inclined to think that there were virtues and vices peculiar to each sect; "and that the sects themselves had an affinity more or less direct with the different temperaments of man; whence the choice of sectators often depended on physical influence, or a peculiar disposition of their organs. Nothing appears more natural than that those men who were born with great force of mind and strong nerves should discover a predilection for stoicism; while mortals endowed by nature with more delicacy of fibres and keener sensibility fled for refuge to the myrtles of Epicurus. People whose temperaments partook of no extremes, were always inclined either for the Lyceum or the Academy. Such as possessed solidity of understanding ranged themselves with Aristotle; and those who had only genius, or even pretensions to that endowment, went to augment the crowd of Platonists."[1]

Grecian mode of philosophizing.

All the systematical philosophers, however, pursued their inquiries into nature by nearly the same method. Of their philosophy, as well as of ours, the universe, with all that it contains, was the vast object; but the individual things which compose the universe are infinite in number and ever changing; and therefore, according to an established maxim of theirs, incapable of being the subjects of human science.[2] To reduce this infinitude, and to fix those fleeting beings, they established certain definite arrangements or classes, to some of which every thing past, present, or to come, might be referred; and having ascertained, as they thought, all that could be affirmed or denied of these classes, they proved, by a very short process of syllogistic reasoning, that what is true of the class must be true of every individual comprehended under it. The most celebrated of these arrangements is that which is known by the name of categories, which Mr Harris thinks at least as old as the era of Pythagoras, and to the forming of which mankind would, in his opinion, be necessarily led by the following considerations. Every subject of human thought is either substance or attribute; but substance and attribute may each of them be modified under the different characters of universal or particular. Hence there arises a quadruple arrangement of things into *substance universal* and *substance particular*, into *attribute universal* and *attribute particular;* to some one of which four not only our words and ideas, but every individual of that immense multitude of things which compose the universe, may be reduced. This arrangement, however, the learned author thinks too limited; and he is of opinion, that, by attending to the substances with which they were surrounded, the Grecian schools must soon have distinguished between the attributes *essential* to all substances, and those which are only *circumstantial;* between the attributes proper to *natural* substances or bodies, and those which are peculiar to *intelligible* substances or minds. He likewise thinks, that the time and place of the existence of substances not present must soon have attracted their attention; and that, in considering the place of this or that substance, they could hardly avoid thinking of its position or situation. He is of opinion that the superinduction of one substance upon another would inevitably suggest the idea of clothing or habit, and that the variety of co-existing substances and attributes would discover to them another attribute, viz. that of relation. Instead, therefore, of confining themselves to the simple division of substance and attribute, they divided attribute itself into nine distinct sorts, some essential and others circumstantial; and thus, by setting substance at their head, made ten comprehensive universal genera, called, with reference to their Greek name, *categories*, and with reference to their Latin name, *predicaments.* These categories are, Substance, Quality, Quantity, Relation, Action, Passion, When, Where, Situation, and Clothing; which, according to the systematic philosophy of the Greeks, comprehend every human science and every subject of human thought. History, natural and civil, springs, says Mr Harris, out of Substance; mathematics out of Quantity; optics out of Quality and Quantity; medicine out of the same; astronomy out of Quantity and Motion; music and mechanics out of the same; painting out of Quality and Site; ethics out of Relation; chronology out of When; geography out of Where; electricity, magnetism, and attraction, out of Action and Passion; and so in other instances.

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[1] Pauw's Philosophical Dissertation.

[2] Boethius *in Prædict. et Arist. Physic.* lib. i.

To these categories, considered as a mere arrangement of science, we are not inclined to make many objections. The arrangement is certainly not complete; but this is a matter of comparatively small importance, for a complete arrangement of science cannot, we believe, be formed. The greatest objection to the categories arises from the use which was made of them by almost every philosopher of the Grecian schools; for those sages having reduced the objects of all human science to ten general heads or general terms, instead of setting themselves to inquire, by a painful induction, into the nature and properties of the real objects before them, employed their time in conceiving what could be predicated of substance in general, of this or that quality, quantity, relation, &c. in the abstract; and they soon found, that of such general conceptions as the categories there are but five predicables or classes of predicates in nature. The first class is that in which the predicate is the genus of the subject; the second, that in which it is the species of the subject; the third is, when the predicate is the specific difference of the subject; the fourth, when it is a property of the subject; and the fifth, when it is something accidental to the subject. Having proceeded thus far in their system, they had nothing to do with individuals but to arrange them under their proper categories, which was commonly done in a very arbitrary manner; and then, with the formality of a syllogism, to predicate of each the predicable of the genus or species to which it belonged. But by this method of proceeding, it is obvious that no progress whatever could be made in physical, metaphysical, or ethical science; for if the individual truly belongs to the category under which it is arranged, we add nothing to our stock of knowledge by affirming or denying of it what we had before affirmed or denied of the whole genus; and if it belong not to the category under which we arrange it, our syllogising will only give the appearance of proof to what must, from the nature of things, be an absolute falsehood. It is only by experiments made on various substances apparently of the same kind that they can be certainly known to belong to the same category; and when this is done, all syllogistic reasoning, from the genus to the species, and from the species to the individual, is but solemn trifling, as every proposition in this retrograde course takes for granted the thing to be proved.

Yet this mode of philosophizing spread from Greece almost over the whole world. It was carried by Alexander into Asia, by his successors into Egypt, and it found its way to Rome after Greece became a province of the empire. It was adopted by the Jews, by the fathers of the Christian church, by the Mahommedan Arabs during the caliphate, and continued to be cultivated by the schoolmen throughout all Europe till its futility was exposed by Lord Bacon. The professors of this philosophy often displayed great acuteness; but their systems were built upon mere hypotheses, and supported by syllogistic wrangling. Now and then indeed a superior genius, such as Alhazen, and our countryman Roger Bacon, broke through the trammels of the schools, and, regardless of the authority of the Stagyrite and his categories, made real discoveries in physical science by experiments judiciously conducted on individual substances; but the science in repute still continued to be that of *generals.* It was indeed a combination of absurd metaphysics with more absurd theology; and that which is properly called physics had in Europe no place in a liberal education from the end of the eighth century to the end of the fourteenth. Towards the beginning of this period of darkness, the whole circle of instruction, or the liberal arts as they were called, consisted of two branches, the *trivium* and the *quadrivium;* the former of which comprehended grammar, rhetoric, and dialectics; the latter music, arithmetic, geometry, and astronomy, to which was added, about the end of the eleventh century, the study of a number of metaphysical subtilties equally useless and unintelligible.

Hitherto the works of the ancient Greek philosophers had been read only in imperfect Latin translations; and before the scholastic system was completely established, Plato and Aristotle had been alternately looked up to as an oracle in science. The rigid schoolmen, however, universally gave the preference to the Stagyrite, because his analysis of body into matter and form is peculiarly calculated to keep in countenance the most incredible doctrine of the Roman Catholic church; and upon the revival of Greek learning this preference was continued after the school philosophy had begun to fall into contempt, on account of much useful information contained in some of his writings on subjects of natural history, and his supposed merit as a natural philosopher. At last the intrepid spirit of Luther and his associates set the minds of men free from the tyranny of ancient names, as well in human science as in theology; and many philosophers sprung up in different countries of Europe, who professed either to be *eclectics*, or to study nature, regardless of every authority except that of reason. Of these the most eminent beyond all comparison was Francis Bacon, Lord Verulam.

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This illustrious man having read with attention the writings of the most celebrated ancients, and made himself master of the sciences which were then cultivated, soon discovered the absurdity of pretending to account for the phenomena of nature by syllogistic reasoning from hypothetical principles; and, with a boldness becoming a genius of the first order, he undertook to give a new chart of human knowledge. This he did in his two admirable works, entitled *De Dignitate et Augmentis Scientiarum;* and *Novum Organum Scientiarum, sive Judicia vera de Interpretatione Naturæ.* In the former of these works, he takes a very minute survey of the whole circle of human science, which he divides into three great branches; history, poetry, and philosophy, corresponding to the three faculties of the mind, memory, imagination, and reason. Each of these general heads is subdivided into minuter branches, and reflections are made upon the whole, which, though we can neither copy nor abridge them, will amply reward the perusal of the attentive reader. The purpose of the *Novum Organum* is to point out the proper method of interpreting nature, which the author shows could never be done by the logic which was then in fashion, but only by a painful and fair induction. "Homo naturæ minister," says he, "et interpres tantum facit et intelligit, quantum de naturæ ordine re, vel mente observaverit; nec amplius scit aut potest. Syllogismus ad principia scientiarum non adhibetur, ad media axiomata frustra adhibetur, cum sit subtilitati naturæ longe impar. Assensum itaque constringit, non res. Syllogismus ex propositionibus constat, propositiones ex verbis, verba notionum tesseræ sunt. Itaque si notiones ipsæ (id quod basis rei est) confusæ sint et temere a rebus abstractæ, nihil in iis quæ superstruuntur, est firmitudinis. Itaque spes est una in *inductione vera.*"

To hypotheses and preconceived opinions, which he calls *idola theatri,* this great man was not less inimical than to syllogisms; and since his days almost every philosopher of eminence, except Descartes and his followers, has professed to study nature according to the method of induction so accurately laid down in the *Novum Organum.* On this method a few improvements have perhaps been made; but notwithstanding these, Lord Bacon must undoubtedly be considered as the author of that philosophy which is now cultivated in Europe, and which will continue to be cultivated as long as men shall have more regard for matters of fact than for hypothetical opinions. Of this mode of philosophizing we shall now give a short, though we hope not inaccurate view, by stating its objects, comparing it with that which it superseded, explaining its rules, and pointing out its uses; and from this view it will appear that its author shares with Aristotle the empire of science.

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The universe, that unbounded object of the contemplation, the curiosity, and the researches of man, may be considered in two different points of view. In the first place, it may be considered merely as a collection of existences, related to each other by means of resemblances and distinction, situation, succession, and derivation, as making parts of a whole. In this view it is the subject of pure description. To acquire an acquaintance with, or a knowledge of, the universe in this point of view, we must enumerate all the beings in it, mention all their sensible qualities, and mark all these relations for each. But this would be labour immense; and when done, an undistinguishable chaos. A book containing every word of a language would only give us the materials, so to speak, of this language. To make it comprehensible, it must be put into some form, which will comprehend the whole in a small compass, and enable the mind to pass easily from one word to another related to it. Of all relations amongst words, the most obvious are those of resemblance and derivation. An etymological dictionary, therefore, in which words have been classed in consequence of their resemblances, and arranged by means of their derivative distinctions, will greatly facilitate the acquisition of the language.

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It is just so in nature. The objects around us may be grouped by means of their resemblance, and then arranged in those groups by means of their distinctions and other relations. In this classification we are enabled to proceed by means of the faculty of abstracting our attention from the circumstances in which things differ, and turning it to those only in which they agree. By the judicious employment of this faculty we are able not only to distribute the individuals into classes, but also to distribute those classes into others still more comprehensive, by discovering circumstances of resemblance amongst them; for the fewer the circumstances are which concur to form that resemblance which has engaged our attention, the greater is the number of similar circumstances which are neglected, and the more extensive will be the class of individuals in which the resemblance is observed. Thus a number of individuals resembling each other in the single circumstance of life composes the most extensive kingdom of Animals. If it be required that they shall further resemble in the circumstance of having feathers, a prodigious number of animals are excluded, and we form the inferior class of Birds. We exclude a great number of birds by requiring a further similarity of web feet, and have the order of Anseres. If we add lingua ciliata, we confine the attention to the genus of Anates. In this manner may the whole objects of the universe be grouped, and arranged into kingdoms, classes, orders, genera, and species.

Such a classification and arrangement is called *Natural History,* and must be considered as the only foundation of any extensive knowledge of nature. To the natural historian, therefore, the world is a collection of existences, the subject of descriptive arrangement. His aim is threefold. 1. To observe with care, and describe with accuracy, the various objects of the universe. 2. To determine and enumerate all the great classes of objects; to distribute and arrange them into all their subordinate classes, through all degrees of subordination, till he arrive at what are only accidental varieties, which are susceptible of no farther distribution; and to mark with precision the principles of this distribution and arrangement, and the characteristics of the various assemblages. 3. To determine with certainty the particular group to which any proposed individual belongs. *Description,* therefore, *arrangement,* and *reference,* constitute the whole of his employment; and in this consists all his science.

Did the universe continue unchanged, this would constitute the whole of our knowledge of nature; but we are witnesses of an uninterrupted succession of changes, and our attention is continually called to the *events* which are incessantly happening around us. These form a set of objects vastly more interesting to us than the former, being the sources of almost all the pleasures or pains we receive from external objects. We are therefore much interested in the study of the events which happen around us, and strongly incited to prosecute it. But they are so numerous and so multifarious, that the study would be immense, without some contrivance for abbreviating and facilitating the task. The same help offers itself here as in the study of what may be called *quiescent nature.* Events, like existences, are susceptible of classification, in consequence of resemblances and distinction; and by attention to these, we can acquire a very extensive acquaintance with active nature. Our attention must be chiefly directed to those circumstances in which many events resemble each other, whilst they differ perhaps in a thousand others. Then we must attend to their most general distinctions; then to distinctions of smaller extent, and so on. It is in this way accordingly that we have advanced in our knowledge of active nature, and are gradually, and by no means slowly, forming assem-

View of Bacon's Philosophy.

blages of events more and more extensive, and distributing these with greater and greater precision into their different classes.

In the zealous and attentive prosecution of this task a very remarkable and interesting observation occurs. In describing those circumstances of similarity amongst events, and particularly in distributing them according to those similarities, it is impossible for us to overlook that constancy which is observed in the changes of nature in the events which are the objects of our contemplation. Events which have once been observed to accompany each other are observed always to do so.

Constancy in the changes of nature.

The rising of the sun is always accompanied by the light of day, and his setting by the darkness of night. Sound argument is accompanied by conviction, impulse by motion, kindness by a feeling of gratitude, and the perception of good by desire. The unexcepted experience of mankind informs us that the events of nature go on in certain regular trains; and if sometimes exceptions seem to contradict this general affirmation, more attentive observation never fails to remove the exception. Most of the spontaneous events of nature are very complicated; and it frequently requires great attention and penetration to discover the simple event amidst a crowd of unessential circumstances which are at once exhibited to our view. But when we succeed in this discovery, we never fail to acknowledge the perfect uniformity of the event to what has been formerly observed. But this is not all. We firmly believe that this uniformity will still continue; that fire will melt wax, will burn paper, will harden clay, as we have formerly observed it to do; and whenever we have undoubted proofs that the circumstances of situation are precisely the same as in some former case, though but once observed, we expect with irresistible and unshaken confidence that the event will also be the same.

It is not surely necessary to produce many proofs of the universality of this law of human thought. The whole language and actions of men are instances of the fact. In all languages there is a mode of construction which is used to express this relation as distinct from all others, and the conversation of the most illiterate never confounds them, except when the conceptions themselves are confounded. The general employment of the active and passive verb is regulated by it. *Turris eversa est a militibus; turris eversa est terræ motu*, express two relations, and no schoolboy will confound them. The distinction therefore is perceived or felt by all who can speak grammatically. Nor is any language without general terms to express this relation. Nay, it is a fact in the mind of brutes, who hourly show that they expect the same uses of every subject which they formerly made of it; and without this, animals would be incapable of subsistence, and man incapable of all improvement. From this alone memory derives all its value; and even the constancy of natural operation would be useless if not matched or adapted to our purposes by this expectation of any confidence in that constancy.

After all the labours of ingenious men to discover the foundation of this irresistible expectation, we must be contented with saying that such is the constitution of the human mind. It is an universal fact in human thought; and, for any thing that has yet been discovered, it is an ultimate fact, not included in any other still more general. We shall soon see that this is sufficient for making it the foundation of true human knowledge, all of which must in like manner be reduced to ultimate facts in human thought. We must consider this undoubted feeling, this persuasion of the constancy of nature, as an instinctive anticipation of events similar to those which we have already experienced. The general analogy of nature should have disposed philosophers to acquiesce in this, however unwelcome to their vanity. In no instance of essential consequence to our safety or well-being are we left to the guidance of our boasted reason; God has given us the surer conduct of natural instincts. No case is so important as this. In none do we so much stand in need of a guide which shall be powerful, infallible, and rapid in its decisions. Without it we must remain incapable of all instruction from experience, and therefore of all improvement.

Our sensations are undoubtedly feelings of our mind. But all those feelings are accompanied by an instinctive reference of them to something distinct from the feelings themselves. Hence arises our perception of external objects, and our very notions of this *externeity*. In like manner, this anticipation of events, this irresistible connection of the idea of fire with the idea of burning, is also a feeling of the mind; and this feeling is by a law of human nature referred, without reasoning, to something external as its cause; and, like our sensation, it is considered as a *sign* of that external something. It is like the conviction of the truth of a mathematical proposition. This is referred by us to something existing in nature, to a necessary and external relation subsisting between the ideas which are the subjects of the proposition. The conviction is the sign or indication of this relation by which it is brought to our view. In precisely the same manner, the irresistible connection of ideas is interpreted as the sensation or sign of a necessary connection of external things or events. These are supposed to include something in their nature which renders them inseparable companions. To this bond of connection between external things we give the name of Causation. All our knowledge of this relation of cause and effect, is the knowledge or consciousness of what passes in our own minds during the contemplation of the phenomena of nature. If we adhere to this view of it, and put this branch of knowledge on the same footing with those called the abstract sciences, considering only the relations of ideas, we shall acquire demonstrative science. If we take any other view of the matter, we shall be led into inextricable mazes of uncertainty and error.

Laws of nature explained.

We see, then, that the natural procedure of our faculty of abstraction and arrangement, in order to acquire a more speedy and comprehensive knowledge of natural events, presents them to our view in another form. We not only see them as similar events, but as events naturally and necessarily conjoined. And the expression of resemblance amongst events is also an expression of concomitancy; and this arrangement of events in consequence of their resemblance is in fact the discovery of those accompaniments. The trains of natural appearance being considered as the appointments of the Author of Nature, has occasioned them to be considered also as consequences of laws imposed on his works by their great author, and every thing is said to be regulated by fixed laws. But this is the language of analogy. When a sovereign determines on certain trains of conduct for his subjects, he issues his orders. These orders are laws. He enforces the observance of them by his authority; and thus a certain regularity and constancy of conduct is produced. But should a stranger, ignorant of the promulgation of these laws, and of the exerted authority of the magistrate, observe this uniformity of conduct, he would ascribe it to the genius and disposition of the people; and his observation would be as useful to him for directing the tenor of his own conduct, as the knowledge of the subject himself of the real source of this constancy is for directing his.

It is just so in nature. Whilst the theologian pretends, from his discoveries concerning the existence and superintendence of God, to know that the constant accompaniment of events is the consequence of laws which the great Author and Governor of the universe has imposed on his works, the ordinary philosopher, a stranger to this scene, and to the unsearchable operations of the Supreme Mind, must as-v of on's oso- y.

cribe this constancy to the nature of the things. There is a great resemblance between the expression natural law and grammatical rule. Rule in strict language implies command; but in grammar it expresses merely a generality of fact, whether of flexion or construction. In like manner, a law of nature is to the philosopher nothing but the expression of a generality of fact. A natural or physical law is a generally observed fact; and whenever we treat any subject as a generally observed fact, we treat it physically. It is a physical law of the understanding that argument is accompanied by conviction; it is a physical law of the affection that distress is accompanied by pity; it is a physical law of the material world that impulse is accompanied by motion. And thus we see that the arrangement of events, or the discovery of those general points of resemblance, is in fact the discovery of the laws of nature; and one of the greatest and most important is, that the laws of nature are constant.

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There is no question that this view of the universe is incomparably more interesting and more important than that which is taken by the natural historian; contemplating everything that is of value to us, and, in short, the whole life and movement of the universe. This study, therefore, has been dignified with the name of Philosophy and of Science; and natural history has been considered as of importance only in as far as it has proved conducive to the successful prosecution of philosophy. But the philosopher claims a superiority on another account. He considers himself as employed in the discovery of causes, saying that philosophy is the study of the objects of the universe as related by causation, and that it is by the discovery of these relations that he communicates to the world such important knowledge. Philosophy, he says, is the science of causes. The vulgar are contented to consider the prior of two inseparably conjoined events as the cause of the other; the stroke on a bell, for instance, as the cause of sound. But it has been clearly shown by the philosopher, that between the blow struck on the bell and the sensation of sound there are interposed a long train of events. The blow sets the bell a trembling; this agitates the air in contact with the bell; this agitates the air immediately beyond it; and thus between the bell and the ear may be interposed a numberless series of events, and as many more between the first impression on the ear and that last impression on the nerve by which the mind is affected. He can no longer therefore follow the nomenclature of the vulgar. Which of the events of this train, therefore, is the cause of the sensation? None of them. It is that something which inseparably connects any two of them, and constitutes their bond of union. These bonds of union or causes he considers as residing in one or both of the connected objects; diversities in this respect must therefore constitute the most important distinctions between them. They are accordingly with great propriety called the qualities, the properties, of these respective subjects.

As the events from which we infer the existence of these qualities of things resemble in many respects such events as are the consequences of the exertion of our own powers, these qualities are frequently denominated powers, forces, energies. Thus, in the instance which has just now been given of the sound of a bell, we infer the powers of impulse, elasticity, nervous irritability, and animal sensibility. In consequence of this inference of a necessary connection between the objects around us, we not only infer the posterior event from the prior, or, in common language, the effect from the cause, but we also infer the prior from the posterior, the cause from the effect. We not only expect that the presence of a magnet will be followed by certain motions in iron filings, but when we observe such motions, we infer the presence and agency of a magnet. Joy is inferred from merriment, poison from death, fire from smoke, and impulse from motion. And thus the appearances of the universe are the indications of the powers of the objects in it. Appearances are the language of nature, informing us of their causes. And as all our knowledge of the sentiments of others is derived from our confidence in their veracity, so all our knowledge of nature is derived from our confidence in the constancy of natural operations. A veracity and credulity necessarily resulting from that law of our mental constitution by which we are capable of speech, conduct us in the one case; and the constancy of nature, and the principle of induction, by which we infer general laws from particular facts, conduct us in the other. As human sentiment is inferred from language, and the existence of external things from sensation, so are the laws of nature, and the powers of natural objects, inferred from the phenomena. It is by the successful study of this language of nature that we derive useful knowledge. The knowledge of the influence of motives on the mind of man enables the statesman to govern kingdoms, and the knowledge of the powers of magnetism enables the mariner to pilot a ship through the pathless ocean.

View of Bacon's Philosophy.

Discoveries of Aristotle and Newton compared.

Such are the lofty pretensions of philosophy. It is to be wished that they should be well founded; for we may be persuaded that a mistake in this particular will be fatal to the advancement of knowledge. An author of great reputation[1] gives us an opportunity of deciding this question in the way of experiment. He says that the ancients were philosophers, employed in the discovery of causes, and that the moderns are only natural historians, contenting themselves with observing the laws of nature, but paying no attention to the causes of things. If he speak of their professed aim, we apprehend that the assertion is pretty just in general. With very few exceptions indeed it may be affirmed of his favourite Aristotle, the philosopher κατ' ἐξοχὴν, and of Sir Isaac Newton. We select these two instances, both because they are set in continual opposition by this author, and because it will be allowed that they were the most eminent students of nature (for we must not yet call them philosophers) in ancient and modern times. Aristotle's professed aim, in his most celebrated writings, is the investigation of causes; and, in the opinion of this author, he has been so successful, that he has hardly left any employment for his successors besides that of commenting upon his works. We must, on the other hand, acknowledge that Newton makes no such pretensions, at least in that work which has immortalized his name, and that his professed aim is merely to investigate the general laws of the planetary motions, and to apply these to the explanation of particular phenomena. Nor will we say that he has left no employment for succeeding inquirers; but, on the contrary, confess that he has only begun the study, has discovered but one law, and has enabled us to explain only the phenomena comprehended in it alone. But he has not been unsuccessful; his investigation has been complete; and he has discovered, beyond all possibility of contradiction, a fact which is observed through the whole extent of the solar system, namely, that every body, nay, that every particle in it, is continually deflected toward every other body, and that every deflection is, in every instance, proportional to the quantity of matter in that body toward which the deflection is directed, and to the reciprocal of the square of the distance from it. He has therefore discovered a physical law of immense extent. Nor has he been in any degree less successful in the explanation of particular phenomena. Of this there cannot be given a better instance

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[1] Ancient Metaphysics.

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than the explanation of the lunar motions from the theory of gravity begun by Newton, *Mathesi sua facem præferente*, and now brought to such a degree of perfection, that if the moon's place be computed from it for any moment within the period of two thousand years back, it will not be found to differ from the place on which she was actually observed by one hundredth part of her own breadth.

> Discimus hinc tandem qua causa argentea Phœbe
> Passibus haud æquis eat, et cur, cognita nulli
> Hactenus astronomo, numerorum frena recusat.
> Quæ toties animos veterum torsere sophorum,
> Quæque scholas hodie rauco certamine vexant,
> Obvia conspicimus, nube pellente mathesi;
> Qua superos penetrare domos, et ardua cœli
> Newtoni auspiciis jam dat contingere templa.

We may now perhaps desire the champions of the science of causes to name any one cause which has really been discovered by their great master, whether in the operations of mind or of body. But they must not on this occasion adduce the investigation of any natural law, in which he has sometimes succeeded. With still greater confidence may we challenge them to produce any remarkable instance of the explanation of natural phenomena, either of mind or body. By explanation we mean an account of the production, and an appreciation of all the circumstances, susceptible of a scrupulous comparison with fact, and perfectly consistent with it. It is here that the weakness of this philosopher's pretensions is most conspicuous; and his followers candidly acknowledge, that in the inquiries which proceed by experiment, we have not derived any great assistance from Aristotle's philosophy. But this, say they, does not derogate from the pre-eminence of his philosophy, because he has shown that the particular fields of observation are to be cultivated only by means of experiment. But surely every field of observation is particular. There is no abstract object of philosophical research, the study of which shall terminate in the philosophy of universals. In every kind of inquiry, that cause alone must be supposed to act which we understand so far as to be able to appreciate its effects in particular circumstances, and compare them with fact, and see their perfect coincidence. If we have discovered causes, they are *known* as far as they are discovered. Their genuine effects are known, and therefore the phenomena which result from their agency are understood. When therefore it is acknowledged, as it must be acknowledged, that mankind have made but little advances in the knowledge of nature, notwithstanding the pretended discovery of causes by Aristotle, and the conducting clue of his philosophy, until of late years; and when it is also allowed that *now*, whilst we are every day making great additions to this subordinate knowledge, the causes which Aristotle has discovered are forgotten, and his philosophy is neglected; there is great room for suspecting, to say the least, that either the causes which philosophy pretends to have discovered are not real, or that Aristotle and his followers have not aimed at the discovery of causes, but only at the discovery of natural laws, and have failed in the attempt.

Philosophical causes.

But there seems here to be a previous question: Is it possible to discover a philosophical cause, that something which is neither the prior nor the posterior of the two immediately adjoining events, but their bond of union, and this, too, distinct from the union itself? It is evident that this is an inquiry purely experimental. It is of human knowledge we speak. This must depend upon the nature of the human mind. This is a matter of contingency, known to us only by experiment and observation. By observing all the feelings and operations of the mind, and classing and arranging them like any other object of science, we discover the general laws of human thought and human reasoning; and this is all the knowledge we can ever acqure of it, or of any thing else.

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Much has been written upon this subject. The most acute observation and the soundest judgment have been employed in the study; and we may venture to say that considerable progress has been made in pneumatology. Many laws of human thought have been observed, and very distinctly marked; and philosophers are busily employed, some of them with considerable success, in the distribution of them into subordinate classes, so as to know their comparative extent, and to mark their distinguishing characters, with a precision similar to that which has been attained in botany and other parts of natural history, so that we may hope that this study will advance like others. But in all these researches no phenomena have occurred which look like the perception or contemplation of these separate objects of thought, these philosophical causes, this power *in abstracto*. No philosopher has ever pretended to state such an object of the mind's observation, or attempted to group them into classes.

We may say at once, without entering into any detail, that those causes, those bonds of necessary union between the naturally conjoined events or objects, are not only perceived by means of the events alone, but are perceived solely in the events, and cannot be distinguished from the conjunctions themselves. They are neither the objects of separate observation, nor the productions of memory, nor inferences drawn from reflection on the laws by which the operation of our own minds are regulated; nor can they be derived from other preceptions in the way of argumentative inference. We cannot infer the paroxysm of terror from the appearance of impending destruction, or the fall of a stone when not supported, as we infer the incommensurability of the diagonal and side of a square. This last is implied in the very conception or notion of a square, not as a consequence of its other properties, but as one of its essential attributes; and the contrary proposition is not only false, but incapable of being distinctly conceived. This is not the case with the other phenomenon, or any matter of fact. The proofs which are brought of a mathematical proposition are not the reason of its being true, but the steps by which this truth is brought into our view; and frequently, as in the instance now given, this truth is perceived, not directly, but consequentially, by the inconceivableness of the contrary proposition.

Mr Hu theory *petitio p cipii.*

Mr Hume derives this irresistible expectation of events from the known effect of custom, the association of ideas. The co-related event is brought into the mind by this well-known power of custom, with that vivacity of conception which constitutes belief or expectation. But without insisting on the futility of his theory of belief, it is sufficient to observe, that this explanation begs the very thing to be proved, when it ascribes to custom a power of any kind. It is the origin of this very power which is the subject in dispute. Besides, upon the genuine principles of scepticism, this custom involves an acknowledgment of past events, of a something different from present impressions, which, in this doctrine, if doctrine it can be called, are the only certain existences in nature; and, lastly, it is known that one clear experience is a sufficient foundation for this unshaken confidence and anticipation. General custom can never, upon Mr Hume's principles, give superior vivacity to any particular idea.

Anothe hypoth

This certain nonentity of it as a separate object of observation, and this impossibility to derive the notion of necessary and causal connection between the events of the universe from any source, have induced two of the most acute philosophers of Europe, Leibnitz and Malebranche, to deny that there is any such connection, and to assert that the events of the universe go on in corresponding trains, but without any causal connection, just as a well-regulated clock will keep time with the motions of the heavens, without any kind of dependence upon them. This harmony of events was pre-established by the Author of the universe, in subserviency to the purposes he had in view in its formation; and all those purposes which are cognisable by us may certainly be accomplished by this perfect adjustment. But without insisting on the fantastical wildness of this ingenious whim, it is quite enough to observe, that it also is a begging of the question, because it supposes causation when it ascribes all to the agency of the Deity.

Thus have we searched every quarter, without being able to find a source from which to derive this perception of a necessary connection amongst the events of the universe, or of this confident expectation of the continuance of physical laws; and yet we are certain of the feeling, and of the persuasion, be its origin what it may; for we speak intelligibly on this subject. We speak familiarly of cause, effect, power, energy, necessary connection, motives and their influence, argument and conviction, reasons and persuasion, allurements and emotions, of gravity, magnetism, irritability, &c.; and we carry on conversations on these subjects with much entertainment and seeming instruction. Language is the expression of thought, and every word expresses some notion or conception of the mind; therefore it must be allowed that we have such notions as are expressed by cause, power, energy. But it is here, as in many cases, we perceive a distinction without being able to express it by a definition; and that we do perceive the relation of causation as distinct from all others, and in particular as distinct from the relation of contiguity in time and place, or the relation of agent, action, and patient, must be concluded from the uniformity of language, which never confounds them except on purpose, and when it is perceived. But even here we shall find, that none of the terms used for expressing those powers of substance which are conceived as the causes of their characteristic phenomena, really express any thing different from the phenomena themselves. Let any person try to define the terms gravity, elasticity, sensibility, and the like, and he will find that the definition is nothing but a description of the phenomena itself. The words are all derivatives, most of them verbal derivatives, implying action, gravitation, and so on. As the general resemblances in shape, colour, or otherwise, are expressed by the natural historian by generic terms, so the general resemblances in event are expressed by the philosopher in generic propositions, which, in the progress of cultivation, are also abbreviated into generic terms.

This abundantly explains the consistency of our language on this subject, both with itself and the operations of nature, without, however, affording any argument for the truth of the assumption, that causes are the objects of philosophical research as separate existences; or that this supposed necessary connection is a *necessary truth*, whether supreme or subordinate. But since the perception of it has its foundation in the constitution of the human mind, it seems entitled to the name of a *first principle*. We are hardly allowed to doubt of this, when we consider the importance of it, and the care of nature to secure us, in all things essential to our safety and well-being, from all danger, from inattention, ignorance, or indolence, by an instinct infallible in its information and instantaneous in its decisions. "It would not be like her usual care," says Hume, "if this operation of the mind, by which we infer like effects from like causes, and *vice versa*, were intrusted to the fallacious deduction of our reason, which is slow in its operations, appears not in any degree during the first years of infancy, and in every age and period of human life is extremely liable to error. It is more conformable to her *ordinary caution* to secure so necessary an act of the mind by some instinct, or blind tendency, which may be infallible and rapid in all its operations, may discover itself at the first appearance of life, and may be independent of all the laboured deductions of reason. As she has taught us the use of our limbs, without giving us any knowledge of the nerves and muscles by which they are actuated; so she has implanted in us an instinct, which carries forward the thought in a course conformable to that established among external objects, though we be ignorant of the powers and forces on which this regularity depends."

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Such a knowledge is quite unnecessary, and therefore causes are no more cognisable by our intellectual powers than colours by a man born blind; nay, whoever will be at the pains to consider this matter agreeably to the received rules and maxims of logic, will find that necessary connection, or the bond of causation, can no more be the subject of philosophical discussion by man than the ultimate nature of truth. It is precisely the same absurdity or incongruity as to propose to examine light with a microscope. Other rational creatures may perceive them as easily as we hear sounds. All that we can say is, that their existence is probable, but by no means certain. Nay, it may be, though we may never know it, that we are not the efficient causes of our own actions, which may be effected by the Deity or by ministering spirits; and this may even be true in the material world. But all this is indifferent to the real occupation of the philosopher, and does not affect either the certainty, the extent, or the utility of the knowledge which he may acquire.

The object of the philosopher the discovery of physical laws.

We are now able to appreciate the high pretensions of the philosopher, and his claim to scientific superiority. We now see that this can neither be founded on any scientific superiority of his object, nor of his employment. His object is not causes, and his discoveries are nothing but the discovery of general facts, the discovery of physical laws; and his employment is the same with that of the descriptive historian. He observes and describes with care and accuracy the events of nature; and then he groups them into classes, in consequence of resembling circumstances, detected in the midst of many others which are dissimilar and occasional. By gradually throwing out more circumstances of resemblance, he renders his classes more extensive; and by carefully marking those circumstances in which the resemblance is observed, he characterizes all the different classes; and by a comparison of these with each other, in respect to the number of resembling circumstances, he distributes his classes according to their generality and subordination; thus exhausting the whole assemblage, and leaving nothing unarranged but accidental varieties. In this procedure it is to be remarked, that every grouping of similar events is, *ipso facto*, discovering a general fact, a physical law; and the expression of this assemblage is the expression of the physical law. And as every observation of this constancy of fact affords an opportunity for exerting the instinctive inference of natural connection between the related subjects, every such observation is the discovery of a power, property, or quality of natural substance. From what has been said, this observation of event is all we know of the connection, all we know of the natural power. And when the philosopher proceeds farther to the arrangement of events, according to their various degrees of complication, he is, *ipso facto*, making an arrangement of all natural powers according to their various degrees of subordinate influence. Thus his occupation is perfectly similar to that of the descriptive historian, namely, classification and arrangement; and this constitutes all the science attainable by both.

Philosophy defined.

Philosophy may therefore be defined the study of the phenomena of the universe, with a view to discover the general laws which indicate the powers of natural substances, to explain subordinate phenomena, and to improve art; or, in compliance with that natural instinct so much spoken of, philosophy is the study of the phenomena of the universe, with a view to discover their causes, to explain subordinate phenomena, and to improve art. The task is undoubtedly

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difficult, and will exercise our noblest powers. The employment is manly in itself, and the result of it important. It therefore justly merits the appellation of *Philosophy*, although its objects are nowise different from what occupy the attention of other men.

The employment of the philosopher.

The employment of the philosopher, like that of the natural historian, is threefold, viz. *description*, *arrangement*, and *reference*; whilst the objects are not *things*, but *events*. The description, when employed about events, may be more properly termed *history*. A philosophical history of nature consists in a complete or copious enumeration and narration of facts, properly selected, cleared of all unnecessary or extraneous circumstances, and accurately narrated. This constitutes the materials of philosophy. We cannot give a better example of this branch of philosophical occupation than astronomy. From the beginning of the Alexandrian school to this day, astronomers have been at immense pains in observing the heavenly bodies, in order to detect their true motions. This has been a work of prodigious difficulty; for the appearances are such as might have been exhibited although the real motions had been extremely different. Not that our senses give us false information; but we form hasty, and frequently false judgments, from these informations; and call those things deceptions of sense, which are in fact errors of judgment. But the true motions have at last been discovered, and have been described with such accuracy, that the history may be considered as nearly complete. This is to be found in the usual systems of astronomy, where the tables contain a most accurate and synoptical account of the motion, so that we can tell with precision in what point of the heavens a planet has been seen at any instant that can be named.

Phenomenology.

Sir Isaac Newton's Optics is such another perfect model of philosophical history, as far as it goes. This part of philosophy may be called *Phenomenology*. Having in this manner obtained the materials of philosophical description, we must put them into a compendious and perspicuous form, so that a general knowledge of the universe may be easily acquired and firmly retained. This is to be done by classification and arrangement, and this classification must proceed upon resemblances observed in the events; and the subsequent arrangement must be regulated by the distinctions of which those resemblances are still susceptible. This assemblage of events into groups must be expressed. They are facts, therefore the expression must be propositions. These propositions must be what the logicians call general or abstract propositions; for they express, not any individual fact of the assemblage, but that circumstance in which they all resemble. Such propositions are the following: Proof is accompanied by belief; kindness is accompanied by gratitude; impulse is accompanied by motion. These are usually called general facts, but there are none such; every fact is individual. This language, however inaccurate, is very safe from misconstruction, and we may use it without scruple. These propositions are *natural* or *physical laws*, and then the detecting or marking those resemblances in event is the investigation of physical laws; and we may denominate this employment of the philosopher *Investigation*.

In the prosecution of this task, it will be found that the similarities of fact are of various extent. And thus we shall form physical laws of various extent, and we shall also find that some are subordinate to others; for the resemblance of a number of facts in one circumstance does not hinder a part of them from also resembling in another circumstance; and thus we shall find subordinations of fact in the same way as of quiescent qualities. And it is found here, as in natural history, that our assemblage of resembling events will be the more extensive as the number of resembling circumstances is smaller; and thus we shall have kingdoms, classes, orders, genera, and species of phenomena, which are expressed by physical laws of all those different ranks.

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It has already been observed, that this observation of physical laws is always accompanied by a reference of that uniformity of event to a natural bond of union between the concomitant facts which is conceived by us as the cause of this concomitancy; and therefore this procedure of the philosopher is considered as the discovery of those causes, that is, the discovery of those powers of natural substances which constitute their physical relations, and may justly be called their distinguishing qualities or properties. This view of the matter gives rise to a new nomenclature and language. We give to those powers generic names, such as sensibility, intelligence, irritability, gravity, elasticity, fluidity, magnetism, and the like. These terms, without exception, mark resembling circumstances of event; and no other definition can be given of them except a description of these circumstances. In a few cases which have been the subjects of more painful or refined discussion, we have proceeded farther in this abbreviation of language.

Aitiol

We have framed the verb "to gravitate," and also the verbal noun "gravitation," which purely expresses the fact, the phenomenon, but is conceived to express the operation or energy of the cause or natural power. It is of importance to keep in mind this metaphysical remark on these terms; for a want of attention to the pure meaning of the words has frequently occasioned very great mistakes in philosophical science. We may with propriety call this part of the philosopher's employment *Aitiology*.

Kepler' laws a instanc

We shall give an instance of its most successful application to the class of events already adduced as an example of philosophical history or phenomenology. Kepler, a celebrated Prussian astronomer, having maturely considered the phenomena recorded in the tables and observations of his predecessors, discovered, amidst all the varieties of the planetary motions, three circumstances of resemblance, which are now known by the name of Kepler's Laws. 1. All the planets describe ellipses, having the sun in one focus. 2. The elliptical areas described by a planet in the different parts of its orbit are proportional to the times of description. 3. The squares of the periodic times are proportional to the cubes of the mean distances from the sun. By this observation or discovery, the study of the planetary motions was greatly promoted, and the calculation of their appearances was now made with a facility and an accuracy which surpassed all hopes; for the calculation of the place of a planet at any proposed instant was reduced to the geometrical problem of cutting off an area from an ellipse of known dimensions, which should bear the same proportion to the whole area, as the time for the duration of which the motion is required has to the known time of a complete revolution.

These compre hended der the more ge ral law gravitat

Long after this discovery of Kepler, Sir Isaac Newton found that these laws of Kepler were only particular cases of a fact or law still more general. He found that the deflections of the planets from uniform rectilineal motion were all directed to the sun; and that the simultaneous deflections were inversely proportional to the squares of the distances from that body. Thus was established a physical law of vast extent. But further observation showed him, that the motion of every body of the solar system was compounded of an original motion of projection, combined with a deflection towards every other body; and that the simultaneous deflections were proportional to the quantity of matter in the body towards which they were directed, and to the reciprocal of the square of the distance from it. Thus was the law made still more general. But he did not stop here. He compared the deflection of the moon in her orbit with the simultaneous deflection of a stone thrown from the hand, and describing a parabola; and he found that they followed the same law, that is, that the deflection of the moon in a second, was to that of the stone in the same time, as the square of the stone's distance from the centre of the earth to the square of the moon's distance from it. Hence he concluded, that the deflection of a stone from a straight line was just a particular instance of the deflections which took place throughout the whole solar system. The deflection of a stone is one of the indications it gives of its being *gravis* or heavy, whence he calls it *gravitation*. He therefore expresses the physical law which obtains throughout the whole solar system by saying that "every body *gravitates* to every other body; and the gravitations are proportional to the quantity of matter in that other body, and inversely proportional to the square of the distance from it."

Thus we see how the arrangement of the celestial phenomena terminated in the discovery of physical laws; and that the expression of this arrangement is the law itself. Since the fall of a heavy body is one instance of the physical law, and since this fall is considered by all as the effect of its *weight*, and this weight is considered as the cause of the fall, the same cause is assigned for all the deflections observed in the solar system, and all the matter in it is found to be under the influence of this cause, or to be heavy; and thus his doctrine has been denominated the *system of universal gravitation*.

Philosophers have gone farther, and supposed that gravity is a power, property, or quality, residing in all the bodies of the solar system. Sir Isaac Newton does not expressly say so, at least in that work where he gives an account of these discoveries. He contents himself with the immediate consequence of the first axiom in natural philosophy, viz. that every body remains in a state of rest, or of uniform rectilineal motion, unless affected by some moving force. Since the bodies of the solar system are neither in a state of rest, nor of uniform rectilineal motion, they must be considered as so affected; that is, that there operates on every one of them a moving force, directed towards all the others, and having the proportions observed in the deflection.

Other philosophers have endeavoured to show, that this general fact, detected by Sir Isaac Newton, is included in another still more general, viz. that every body moves which is impelled by another body in motion. They assert, that all the bodies of the solar system are continually impelled by means of a fluid which they call *ether*, which is moving in all places, and in all directions, or in circular vortices, and hurries along with it the planets and all heavy bodies. It would seem that the familiarity of motion produced by impulse, at least in those instances in which our own exertions are most employed, has induced philosophers to adopt such notions; perhaps, too, they are influenced by an obscure and indistinct notion affixed to the term action, as applied to changes in the material world, and which has given rise to an axiom, "that a body cannot act at a distance, or where it is not," and thus have thought themselves obliged to look out for an immediate and contiguous agent in all these phenomena.

But the philosophers who profess to be most scrupulous in their adherence to the rules of philosophic discussion deny the legitimacy of this pretended investigation of causes, saying that this doctrine is in direct opposition to the procedure of the mind in acquiring the knowledge of causes. Since the fact of impulse is not really observed in the celestial deflections, nor in the motions of heavy bodies, the law cannot be inferred. They say that it is not even necessary to show that the phenomena of the celestial motions are unlike the phenomena of impulse, although this can be done in the completest manner. It is enough that neither the fluid nor the impulse are observed; and therefore they are in the right when they assert that there is inherent in, or accompanies, all the bodies of the system, a power by which they deflect to one another. The debate is foreign to our present purpose, which is only to show how the observation and arrangement of phenomena terminate in the discovery of their causes, or the discovery of the powers or properties of natural substances. This is a task of great difficulty, as it is of great importance.

Causes of the difficulty of philosophical investigation.

There are two chief causes of this difficulty. 1. In most of the spontaneous phenomena of nature there is a complication of many events, and some of them escape our observation. Attending only to the most obvious or remarkable, we conjoin these only in our imagination, and are apt to think these the concomitant events in nature, the proper indication of the cause, and the subjects of this philosophical relation, and to suppose that they are always conjoined by nature. Thus it was thought that there resided in a vibrating chord a power by which the sensation of sound was excited, or that a chord had a sounding quality. But it appears clearly from observation that there is an inconceivable number of events interposed between the vibration of the chord and the sensitive affection of our ear; and therefore, that sound is not the effect of the vibration of the chord, but of the very last event of this series; and this is completely demonstrated by showing that the vibration and the sound are not necessarily connected, because they are not always connected, but require the interposition of air or of some other elastic body. These observations show the necessity of the most accurate and minute observation of the phenomena, that none of those intermediate events may escape us, and we be thus exposed to the chance of imaginary connections between events which are really far asunder in the procedure of nature. As the study has improved, mistakes of this kind have been corrected; and philosophers have become careful to make their trains of events under one name as short as possible. Thus, in medicine, a drug is no longer considered as a specific remedy for the disease which is sometimes cured when it has been used, but is denominated by its most immediate operation on the animal frame; it is no longer called a febrifuge, but a sudorific.

2. When many natural powers combine their influence in a spontaneous phenomenon of nature, it is frequently very difficult to discover what part of the complicated effect is the effect of each; and to state those circumstances of similarity which are the foundation of a physical law, or entitle us to infer the agency of any natural power. The most likely method for insuring success in such cases is to get rid of this complication of event, by putting the subject into such a situation that the operation of all the known powers of nature shall be suspended, or so modified as that we may perfectly understand their effects. We can thus appreciate the effects of such as we could neither modify nor suspend, or we can discover the existence of a new law, the operation of a new power.

Experimental philosophy.

This, which is called *making an experiment*, is, of all, the most effectual way of advancing in the knowledge of nature, and it has been called *Experimental Philosophy*. It seems, however, at first sight, in direct opposition to the procedure of nature in forming general laws. These are formed by induction from multitudes of individual facts, and must be affirmed to no greater extent than the induction on which they are founded. Yet it is a matter of fact, a physical law of human thought, that one simple, clear, and unequivocal experiment gives us the most complete confidence in the truth of a general conclusion from it to every similar case. Whence this anomaly? It is not an anomaly or contradiction of the general maxim of philosophical investigation, but the most refined application of it. There is no law more general than this, that "Nature is constant in all her operations." The judicious and simple form of our experiment insures us in the complete knowledge of all the circumstances of the event. Upon this supposition, and upon this alone, we consider the experiment as the faithful representative of every possible case of the conjunction. This will be more minutely considered afterwards.

Theory or explanation of subordinate phenomena.

The last branch of philosophical occupation is the explanation of subordinate phenomena. This is nothing more than the referring any particular phenomenon to that class in which it is included; or, in the language of philosophy, it is the pointing out the general law, or that general fact of which the phenomenon is a particular instance. Thus the feeling of the obligations of virtue is thought to be explained when it is shown to be a particular case of that regard which every person has for his dearest interests. The rise of water in pumps is explained when we show it to be a particular case of the pressure of fluids, or of the air. The general law under which we show it to be properly arranged is called the *principle* of the explanation, and the explanation itself is called the *theory* of the phenomenon. Thus Euler's explanation of the lunar irregularities is called a theory of the lunar motions on the principle of gravitation. This may be done either in order to advance our own knowledge of nature, or to communicate it to others. If done with the first view, we must examine the phenomenon minutely, and endeavour to detect every circumstance in it, and thus discover all the known laws of nature which concur in its production; we then appreciate the operation of each, according to the circumstances of its exertion; we then combine all these, and compare the result with the phenomenon. If they are similar, we have explained the phenomenon. We cannot give a better example than Franklin's explanation of the phenomena of thunder and lightning.

If we explain a phenomenon from known principles, we proceed synthetically from the general law already established and known to exert its influence in the present instance. We state this influence both in kind and degree, according to the circumstances of the case; and having combined them, we compare the result with the phenomenon, and show their agreement, and thus it is explained. Thus, because all the bodies of the solar system mutually gravitate, the moon gravitates to the sun as well as to the earth, and is continually, and in a certain determinate manner, deflected from that part which she would describe did she gravitate only to the earth. Her motion round the earth will be retarded during the first and third quarters of her orbit, and accelerated during the second and fourth. Her orbit and her period will be increased during our winter, and diminished during our summer. Her apogee will advance, and her nodes will recede; the inclination of her orbit will be greatest when the nodes are in syzigee, and least when they are in quadrature; and all these variations will be in certain precise degrees. Then we show that all these things actually obtain the lunar motions, and they are considered as explained.

Fundamental proposition of philosophical discussion.

This summary account of the object and employment in all philosophical discussion is sufficient for pointing out its place in the circle of the sciences, and will serve to direct us to the proper methods of prosecuting it with success. Events are its object; and they are considered as connected with each other by causation, which may therefore be called the philosophical relation of things. The following may be adopted as the fundamental proposition on which all philosophical discussion proceeds, and under which every philosophical discussion or discovery may be arranged:—"Every change that we observe in the state or condition of things *is considered by us* as an effect, indicating the agency, characterizing the kind, and determining the degree of its *inferred* cause."

As thus enounced, this proposition is evidently a physical law of human thought. It may be enounced as a necessary and independent truth, by saying that every change in the state and condition of things *is an effect*, &c. And accordingly it has been so enounced by Dr Reid;[1] and its title to this denomination has been abundantly supported by him. But we have no occasion to consider it as possessing this quality. We are speaking of philosophy, which is something contingent, depending on the existence and constitution of an intellectual being such as man; and, in conformity to the view which we have endeavoured to give of human knowledge in the subjects of philosophical relation, it is quite sufficient for our purpose that we maintain its title to the rank of an universal law of human thought. This will make it a first principle, even although it may not be a necessary truth.

All the proof necessary for this purpose is universality of fact; and we believe this to be without exception. We are not to expect that all mankind have made, or will ever make, a formal declaration of their opinion; but we may venture to say that all have made it, and continually do make it, virtually. What have the philosophers of all ages been employed about except the discovery of the causes of those changes that are incessantly going on? "Nil turpius physico," says Cicero, "quam fieri sine causa quidquam dicere." Human curiosity has been directed to nothing so powerfully and so constantly as to this. Many absurd causes have been assigned for the phenomena of the universe; but no set of men have ever said that they happened without a cause. This is so repugnant to all our propensities and instincts, that even the atheistical philosophers, who, of all others, would have profited most by the doctrine, have never thought of advancing it. To avoid so shocking an absurdity, they have rather allowed that chance, and the concourse of atoms, are the causes of the beautiful arrangements of nature. The thoughtless vulgar are no less solicitous than the philosophers to discover the cause of things; and the poet expresses the natural and instinctive passion of all men when he says,

> Felix qui potuit rerum cognoscere causas.

And this anxiety is not to nourish, but to get rid of superstitious fears; for thus

> ...... metus omnes, et inexorabile fatum
> Subjecit pedibus, strepitumque Acherontis avari.

Had men never speculated, their conduct alone gives sufficient evidence of the universality of the opinion. The whole conduct of man is regulated by it, nay, almost wholly proceeds upon it, in the most important matters, and where experience seems to leave us in doubt; and to act otherwise, as if any thing whatever happened without a cause, would be a declaration of insanity. Dr Reid has beautifully illustrated this truth, by observing, that even a child will laugh at you if you try to persuade him that the top, which he misses from the place where he left it, was taken away by nobody. You may persuade him that it was taken away by a fairy or a spirit; but he believes no more about this nobody than the master of the house, when *he* is told that nobody was the author of any piece of theft or mischief. What opinion would be formed, says Dr Reid, of the intellects of the juryman, on a trial for murder by persons unknown, who should say that the fractured skull, the watch and money gone, and other like circumstances, might possibly have no cause? He would be pronounced insane or corrupted.

This ciple trove by M Hum

We believe that Mr Hume is the first author who has ventured to call the truth of this opinion in question; and even he does it only in the way of mere possibility. He acknowledges the generality of the opinion, and he only objects to the foundation of this generality; and he objects to it merely because it does not quadrate with his theory of belief, and therefore it may happen that some men may have no such opinion. But it must be observed on this occasion, that the opinion of a philosopher is of no greater weight in a case like this than that of a ploughboy. If it be a first principle, directing the opinions and actions of all, it must operate on the minds of all. The philosopher is the only person who may chance to be without it; for it requires much labour, and long habits resolutely maintained, to warp our natural sentiments; and experience shows us that they may be warped if we are at sufficient pains. It is also worthy of remark, that this philosopher seems as much under the influence of this law as ordinary mortals. It is only when he is aware of its not tallying with his other doctrines that his scruples appear. Observe how he speaks when off his guard: "As to those impressions which arise from the senses, their ultimate cause is, in my opinion, perfectly inexplicable by human reason; and it will always be impossible to decide with certainty whether they arise immediately from the object, are produced by the creative power of the mind, or are derived from the Author of our being."

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[1] Essays on the Intellectual Powers of Man.

Amongst these alternatives he never thought of their not being derived from any cause. But it is not enough to show that this is a physical law of the human mind. We have assumed it as a first principle, the foundation of a whole science, and therefore not included in or derived from any thing more general. Mr Hume's endeavours to prove that it is not a necessary truth, show with sufficient evidence that most attempts to derive it in the way of argument are *petitiones principii;* a thing very commonly met with in all attempts to prove first principles. It cannot be proved by induction of facts that every event has a cause, because induction always supposes an observed fact or event. Now in by far the greater number of events the causes are unknown. Perhaps in no event whatever do we know the real cause, or that power or energy which, without any intervention, produces the effect. No man can say that, in the simplest event which he ever observed, he was fully apprised of every circumstance which concurred to its production. We suppose that no event in nature can be adduced more simple than the motion of a suspended glass ball when gently struck by another glass ball; and we imagine that most of our readers will say that they perfectly see every thing which happens in this phenomenon. We believe, too, that most of our readers are of opinion that a body is never put in motion but by the impulse of another, except in the cases of animal motion; and that they are disposed to imagine that magnets put iron in motion, and that an electrified body moves another, by means of an interposed though invisible fluid somehow circulating round them. Now we must inform such readers, that unless the stroke has been very smart, so smart indeed as to shatter the glass balls, the motion of the suspended ball was produced without impulse; that is, the two balls were not in contact during the stroke, and the distance between them was not less than the nine thousandth part of an inch, and probably much greater. We must say farther, that it is not certain that even the violent stroke, such as would shatter them to pieces, is enough to bring them into real contact.

Unless, therefore, our readers are willing to allow that the suspended ball was put in motion by a repulsive force inherent in one or both balls, they must acknowledge that they do not fully know all the circumstances of this so simple phenomenon, or all the train of events which happen in it; and therefore they are reduced to the necessity of supposing, although they do not see it, an intervening fluid or matter, by the immediate action of the adjoining particles of which the motion is produced.

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This being the case in the simplest phenomenon that we can pitch upon, what shall we say of the numberless multitudes which are incomparably more complex. Must we not acknowledge that the efficient causes, even in the vulgar sense of the word, the immediately preceding events, are unknown, because the conjunctions are not observed; and therefore it cannot be said that it is from experimental induction that this truth gains universal belief. Experience, so far from supporting it as a direct proof, seems rather the strongest argument against it; for we have no experiment of unquestionable authority but the narrow circle of our own power exerted upon our thoughts and actions. And even here there are perhaps cases of change where we cannot say with certainty that we perceive the efficient cause. Nothing seems to remain, therefore, but to allow that this physical law of human judgment is instinctive, a constituent of the human soul, a first principle, and incapable of any other proof than the appeal to the feelings of every man.

Causes not observed, but inferred from the phenomena.

Simply to state, that every change is considered as an effect, is not giving the whole characters of this physical law. The cause is not always, perhaps never, observed, but it is inferred from the phenomena. The inference is therefore in every instance dependent on the phenomenon. The phenomenon is to us the language of nature. It is therefore the sole indication of the cause and of its agency; it is the indication of the very cause, and of no other. The observed change therefore characterizes the cause, and marks its kind. This is confirmed by every word of philosophical language, where, as has already been observed, the names of the inferred powers of nature are nothing but either abbreviated descriptions of the phenomena, or terms which are defined solely by such descriptions. In like manner, the phenomenon determines the cause in a particular degree, and in no other; and we have no immediate measure of the degree of the cause but the phenomenon itself. We take many measures of the cause, it is true; but on examination they will be found not to be immediate measures of the cause, but of the effect. Assuming gravitation as the cause of the planetary deviations from uniform rectilineal motion, we say that the gravitation of the moon is but $\frac{1}{3600}$th part of the gravitation of a stone thrown from the hand; but we say this only from observing that the deflection of the stone is three thousand six hundred times greater than the simultaneous deflection of the moon. In short, our whole knowledge of the cause is not only founded on our knowledge of the phenomenon, but it is the same. This will be found a remark of immense consequence in the prosecution of philosophical researches; and a strict attention to it will not only guard us against a thousand mistakes into which the reasoning pride of man would continually lead us, but will also enable us fully to detect may egregious and fatal blunders made in consequence of this philosophical vanity. Nothing can be more evident than that, whenever we are puzzled, it would be folly to continue groping amongst those obscure beings called causes, when we have their prototypes, the phenomena themselves, in our hands.

Such is the account which may be given of philosophy, the study of the works of God, as related by causation. It is of vast extent, reaching from an atom to the glorious Author of the universe, and contemplating the whole connected chain of intelligent, sensitive, and inanimate beings. The philosopher makes use of the descriptions and arrangements of the natural historian as of mighty use to himself in the beginning of his career, confiding in the uniformity of nature, and expecting that similarity in the quiescent properties of things will be accompanied by some resemblances in those more important properties which constitute their mutual dependencies, linking them together in a great and endlessly-ramified chain of events.

We have endeavoured to ascertain with precision the peculiar province of philosophy, both by means of its object and its mode of procedure. After this it will not require many words to point out the methods for prosecuting the study with expedition and with success. The rules of philosophizing, which Newton premises in his account of the

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planetary motions, which he so scrupulously followed, and with a success which gives them great authority, are all in strict conformity to the view we have now given of the subject.

The chief rule of philosophizing explained.

The chief rule is, that similar causes are to be assigned to similar phenomena. This is indeed the source of all our knowledge of connected nature; and without it the universe would only present to us an incomprehensible chaos. It is by no means, however, necessary to enjoin this as a maxim for our procedure; it is an instinctive propensity of the human mind. It is absolutely necessary, on the contrary, to caution us in the application of this propensity. We must be extremely confident in the certainty of the resemblance before we venture to make any inference. We are prone to reason from analogy; the very employment is agreeable, and we are ever disposed to embrace opportunities of engaging in it. For this reason we are satisfied with very slight resemblances, and eagerly run over the consequences, as if the resemblance were complete; and our researches frequently terminate in falsehood.

This propensity to analogical reasoning is aided by another equally strong, and equally useful when properly directed; we mean the propensity to form general laws. This is in fact a propensity to discover causes, which is equivalent to the establishing of general laws. It appears in another form, and is called a love of or taste for simplicity; and this is encouraged or justified, as agreeable to the uniformity and simplicity of nature. "Natura semper sibi similis et consona," says Newton. "Frustra fit per plura, quod fieri potest per pauciora," says another. The beautiful, the wise economy of nature, are phrases in every body's mouth; and Newton enjoins us to adopt no more causes than are sufficient to explain the phenomena. All this is very well, and is true in its own degree; but it is too frequently the subterfuge of human vanity and self-love. This inordinate admiration of the economy and simplicity of nature is generally conjoined with a manifest love of system, and with the actual production of some new system, where from one general principle some extensive theory or explanation is deduced and offered to the world. The author sees a sort of resemblance between a certain series of phenomena and the consequences of some principle, and thinks the principle adequate to their explanation. Then, on the authority of the acknowledged simplicity of nature, he roundly excludes all other principles of explanation; because, says he, this principle is sufficient, "et frustra fit per plura," &c. We could point out many instances of this kind in the writings of perhaps the first mathematician and the poorest philosopher of this century; where extensive theories are thus cavalierly exhibited, which a few years' examination have shown to be nothing but analogies, indistinctly observed, and, what is worse, inaccurately applied.

A true cause explained.

To regulate these hazardous propensities, and thus to keep philosophers in the right path, Newton inculcates another rule, or rather gives a modification of this injunction of simplicity. He enjoins that no cause shall be admitted but what is real. His words are, that "no causes shall be admitted but such as are true, and sufficient to account for the phenomena." We apprehend that the meaning of this rule has been mistaken by many philosophers, who imagine that by true he means causes which really exist in nature, and are not mere creatures of the imagination. We have met with some who would boggle at the doctrines of Aristotle respecting the planetary motions, viz. that they are carried along by conducting intelligent minds, because we know of none such in the universe; and who would nevertheless think the doctrine of the Cartesian vortices deserving of at least an examination, because we see such vortices exist, and produce effects which have some resemblance to the planetary motions, and have justly rejected them, solely because this resemblance has been very imperfect. We apprehend Newton's meaning by these words is, that no cause of any event shall be admitted, or even considered, which we do not know to be actually concurring or exerting some influence in that very event. If this be his meaning, he would reject the Cartesian vortices, and the conducting spirits of Aristotle, for one and the same reason; not because they were not adequate to the explanation, nor because such causes do not exist in nature, but because we did not see them anyhow concerned in the phenomenon under consideration. We neither see a spirit nor a vortex, and therefore need not trouble ourselves with inquiring what effects they would produce. Now we know that this was his very conduct, and what has distinguished him from all philosophers who preceded him, though many, by following his example, have also been rewarded by similar success. This has procured to Newton the character of the modest philosopher; and modest his procedure may, for distinction's sake, be called, because the contrary procedure of others did not originate so much from ignorance as from vanity. Newton's conductor in this was not modesty, but sagacity, prudence, caution, and, to say it purely, it was sound judgment.

For the bonds of nature, the supposed philosophical causes are not observed; they are only inferred from the phenomena. When two substances are observed, and only when they are observed to be connected in any series of events, we infer that they are connected by a natural power; but when one of the substances is not seen, but fancied, no law of human thought produces any inference whatever. For this reason alone Newton stopped short at the last fact which he could discover in the solar system, that all bodies were deflected to all other bodies, according to certain regulations of distance and quantity of matter. When told that he had done nothing in philosophy, that he had discovered no cause, and that to merit any praise he must show how this deflection was produced, he said that he knew no more than he had told them; that he saw nothing causing this deflection, and was contented with having discovered it so exactly, that a good mathematician could now make tables of the planetary motions as accurate as he pleased, and with hoping in a few years to have every purpose of navigation and of philosophical curiosity completely answered; and he was not disappointed. And when philosophers on all sides were contriving hypothetical fluids and vortices which would produce these deflections, he contented himself with proving the total inconsistency of these explanations with the mechanical principles acknowledged by their authors; showing that they had transgressed both parts of his rule, their causes neither being real, nor sufficient for explaining the phenomena. A cause is sufficient for explaining a phenomenon only when its legitimate consequences are perfectly agreeable to these phenomena.

This d trine fo ed in re son.

Newton's discoveries remain without any diminution or change; no philosopher has yet advanced a step farther. But let not the authority, nor even the success, of Newton, be our guide. Is his rule founded in reason? It surely is. For if philosophy be the only interpretation of nature's language, the inference of causes from the phenomena, a fancied or hypothetical phenomenon can produce nothing but a fanciful cause, and can make no addition to our knowledge of real nature.

Danger hypoth

All hypotheses therefore must be banished from philosophical discussion as frivolous and useless, administering to vanity alone. As the explanation of any appearance is nothing but the pointing out the general fact, of which this is a particular instance, a hypothesis can give no explanation; knowing nothing of cause and effect but the conjunction of two events, we see nothing of causation where one of the events is hypothetical. Although all the legitimate consequences of a hypothetical principle should be perfectly similar to the phenomenon, it is extremely dangerous to assume this principle as the real cause. It is illogical to make use of the economy of nature as an argument for the truth of any hypothesis; for, if true, it is a physical truth, a matter of fact, and true only to the extent in which it is observed; and we are not entitled to say that it is so one step farther, therefore not in this case till it be observed. But the proposition that nature is so economical, is false; and it is astonishing that it has been so lazily acquiesced in by the readers of hypotheses; for it is not the authors who are deceived by it; they are generally led by their own vanity. Nothing is more observable than the prodigious variety of nature. That the same phenomena may be produced by different means, is well known to the astronomers, who must all grant that the appearances of motion will be precisely the same whether the earth moves round the sun like the other planets, or whether the sun with his attendant planets moves round the earth; and that the demonstration of the first opinion is had from a fact totally unconnected with all the deflections, or even with their causes; for it may be asserted, that Dr Bradley's discovery of the aberration of the fixed stars, in consequence of the progressive motion of light, was the first thing which put the Copernican system beyond question; and even this is still capable of being explained in another way. The Author of nature seems to delight in variety; and there cannot be named a single purpose on which the most inconceivable fertility in resource is not observed. It is the most delightful occupation of the curious mind and the sensible heart to contemplate the various contrivances of nature in accomplishing similar ends.

As a principle, therefore, on which to found any maxim of philosophical procedure, this is not only injudicious, because imprudent and apt to mislead, but as false, and almost sure to mislead. In conformity to this observation, it must be added, that nothing has done so much harm in philosophy as the introduction of hypotheses.

Authors have commonly been satisfied with very slight resemblances, and readers are easily misled by the appearances of reasoning which these resemblances have countenanced. The ancients, and above all Aristotle, were much given to this mode of explanation. and have filled philosophy with absurdities. The slightest resemblances were with them sufficient foundations of theories. It has been by very slow degrees that men have learned caution in this respect; and we are sorry to say that we are not yet cured of the disease of hypothetical systematizing, and to see attempts made by ingenious men to bring the frivolous theories of antiquity again into credit. Nay, modern philosophers, even of the greatest name, are by no means exempted from the reproach of hypothetical theories. Their writings abound in ethers, nervous fluids, animal spirits, vortices, vibrations, and other invisible agents. We may affirm that all these attempts may be shown to be either unintelligible, fruitless, or false. Either the hypothesis has been such that no consequence can be distinctly drawn from it, on account of its obscurity and total want of resemblance to any thing we know; or the just and legitimate consequences of the hypothesis are inconsistent with the phenomena. This is remarkably the case in the hypotheses which have been introduced for the explanation of the mechanical phenomena of the universe. These can be examined by accurate science, and the consequences compared without any mistake; and nothing else but a perfect agreement should induce us even to listen to any hypothesis whatever.

It may be here asked, Whether, in the case of the most perfect agreement, after the most extensive comparison, the hypothesis should be admitted? We believe that this must be left to the feelings of the mind. When the belief is irresistible, we can reason no more. But as there is no impossibility of as perfect an agreement with some other hypothesis, it is evident that it does not convey an irrefragable title to our hypothesis. It is said, that such an agreement authorizes the reception of the hypothetical theory, in the same manner as we must admit that to be the true cipher of a letter which will make perfect sense of it. But this is not true. In deciphering a letter we know the sounds which must be represented by the characters, and that they are really the constituents of speech; but in hypothetical explanations the first principle is not known to exist; nay, it is possible to make two ciphers, each of which shall give a meaning to the letter. Instances of this are to be seen in treatises on the art of deciphering.

We conclude our criticism on hypothetical explanations with this observation, that it is *impossible* that they can make any addition to our knowledge. In every hypothesis we thrust in an intermediate event between the phenomenon and some general law; and this event is not seen, but supposed. Therefore, according to the true maxims of philosophical investigation, we give no explanation; for we are not by this means enabled to assign the general law in which this particular phenomenon is included. Nay, the hypothesis makes no addition whatever to our list of general laws; for our hypotheses must be selected, in order to tally with all the phenomena. The hypothesis therefore is understood only by and in the phenomena, and it must not be made more general than the phenomena themselves. The hypothesis gives no generalization of facts. Its very application is founded on a great coincidence of facts; and the hypothetical fact is thrust in between two which we really observe to be united by nature. The applicability, therefore, of the hypothesis is not more extensive than the similarity of facts which we observe, and the hypothetical law is not more general than the observed law. Let us then throw away entirely the hypothetical law, and insert the observed one in our list of general laws; it will be in different language from the hypothetical law, but it will express the same facts in nature.

On what occasions hypotheses may be useful.

It is in experimental philosophy alone that hypotheses can have any just claim to admission; and here they are not admitted as explanations, but as conjectures serving to direct our line of experiments. Effects only appear; and by their appearance, and the previous information of experience, causes are immediately ascertained by the perfect similarity of the whole train of events to other trains formerly observed. Or they are suggested by more imperfect resemblances of the phenomena; and these suggestions are made with stronger or fainter evidence, according as the resemblance is more or less perfect. These suggestions do not amount to a confidential inference, and only raise a conjecture. Wishing to verify or overturn this conjecture, we have recourse to experiment; and we put the subject under consideration in such a situation that we can say what will be the effect of the conjectural cause if real. If this tallies with the appearance, our conjecture has more probability of truth, and we vary the situation, which will produce a new set of effects of the conjectured cause, and so on. It is evident that the probability of our conjecture will increase with the increase of the conformity of the legitimate effects of the supposed cause with the phenomena, and that it will be entirely destroyed by one disagreement. In this way conjectures have their great use, and are the ordinary means by which experimental philosophy is improved. But conjectural systems are worse than nonsense, filling the mind with false notions of nature, and generally leading us into a course of improper conduct when they become principles of action. This is acknowledged even by the abettors of hypothetical systems themselves when employed in overturning those of their predecessors, and establishing their own; witness the successive maintainers of the many hypothetical systems in medicine,

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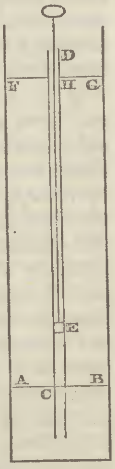
which have had their short-lived course within these two last centuries. Let every person, therefore, who calls himself a philosopher, resolutely determine to reject all temptations to this kind of system-making, and let him never consider a composition of this kind as any thing better than the amusement of an idle hour.

True mode of philosophical procedure.

After these observations, it cannot require much discussion to mark the mode of procedure which will insure progress in all philosophical investigations. The sphere of our intuitive knowledge being very limited, we must be indebted for the greatest part of our intellectual attainments to our rational powers, and it must be deductive. In the spontaneous phenomena of nature, whether of mind or body, it seldom happens that the energy of that natural power, which is the principle of explanation, is so immediately connected with the phenomenon that we can see the connection at once. Its exertions are frequently concealed, and in all cases modified, by the joint exertions of other natural powers; hence the particular exertion of each must be considered apart, and their mutual connection traced out. It is only in this way that we can discover the perhaps long train of intermediate operations, and also see in what manner and degree the real principle of explanation concurs in the ostensible process of nature.

In all such cases it is evident that our investigation (and investigation it most strictly is) must proceed by successive steps, conducted by the sure hand of logical method. To take an instance from the material world, let us listen to Galileo whilst he is teaching his friends the cause of the rise of water in a pump. He says that it is owing to the pressure of the air. This is his principle; and he announces it in all its extent. All matter, says he, is heavy, and in particular air is heavy. He then points out the connection of this general principle with the phenomenon. Air being heavy, it must be supported; it must lie and press on what supports it; it must press on the surface AB of the water in the cistern surrounding the pipe CD of the pump; and also on the water C within this pipe. He then takes notice of another general principle which exerts its subordinate influence in this process. Water is a fluid; a fluid is a body the parts of which yield to the smallest impression, and, by yielding, are easily moved amongst themselves; and no little parcel of the fluid can remain at rest unless it be equally pressed in every direction, but will recede from that side where it sustains the greatest pressure. In consequence of this fluidity, known to be a property of water, if any part of it is pressed, the pressure is propagated through the whole; and if not resisted upon every side, the water will move to that side where the propagated pressure is not resisted. All these subordinate or collateral propositions are supposed to be previously demonstrated or allowed. Water, therefore, must yield to the pressure of the air, unless pressed by it upon every side, and must move to that side where it is not withheld by some opposite pressure. He then proceeds to show, from the structure of the pump, that there is no opposing pressure on the water in the inside of the pump. "For," says he, "suppose the piston thrust down till it touches the surface of the water in the pipe; suppose the piston now drawn up by a power sufficient to lift it, and all the air incumbent on it; and suppose it drawn up a foot or fathom, there remains now nothing that I know of to press on the surface of the water. In short," says he, "gentlemen, it appears to me that the water in the pump is in the same situation that it would be in were there no air at all, but water poured into the cistern to a height AF; such, that the column of water FABG presses on the surface AB as much as the air does. Now, in this case, we know that the water at C is pressed upwards with a force equal to the weight of a column of water having the section of the pipe for its base and CH for its height. The water below C, therefore, will be pressed up into the pipe CD, and will rise to G, so that it is on a level with the external water FG; that is, it will rise to H. This is a necessary consequence of the weight and pressure of the incumbent column FABG, and the fluidity of the water in the cistern. Consequences perfectly similar must necessarily follow from the weight and pressure of the air; and therefore, upon drawing up the piston from the surface C of the water with which it was in contact, the water must follow it till it attain that height which will make its own weight a balance for the pressure of the circumambient air. Accordingly, gentlemen, the Italian plumbers inform me that a pump will not raise water quite fifty palms; and from their information I conclude, that a pillar of water fifty palms high is somewhat heavier than a pillar of air of the same base, and reaching to the top of the atmosphere."



View- Bacon Philo- phy.

The syn- thetica metho

Thus is the phenomenon explained. The rise of the water in the pump is shown to be a particular case of the general fact in hydrostatics, that fluids in communicating vessels will stand at heights which are inversely as their densities, or that columns of equal weights are in equilibrio. This way of proceeding is called arguing *a priori*, or the synthetical method. It is founded on just principles; and the great progress which we have made in the mathematical sciences by this mode of reasoning shows to what length it may be carried with irresistible evidence. It has long been considered as the only inlet to true knowledge; and nothing was allowed to be known with certainty which could not be demonstrated in this way to be true. Accordingly logic, or the art of reasoning, which was also called the art of discovering truth, was nothing but a set of rules for successfully conducting this mode of argument.

Under the direction of this infallible guide, it is not surely unreasonable to expect that philosophy should make sure progress towards perfection; and as we know that the brightest geniuses of Athens and of Rome were for ages solely occupied in philosophical researches in every path of human knowledge, it is equally reasonable to suppose that the progress has not only been sure, but great. We have seen that the explanation of an appearance in nature is nothing but the arrangement of it into that general class in which it is comprehended. The class has its distinguishing mark, which, when it is found in the phenomenon under consideration, fixes it in its class, there to remain for ever an addition to our stock of knowledge. Nothing can be lost any other way but by forgetting it; and the doctrines of philosophers must be stable, like the laws of nature.

We have seen, however, that the very reverse of all this is the case; that philosophy has but very lately emerged from worse than total darkness and ignorance; that what passed under the name of philosophy was nothing but systems of errors, if systems they could be called, which were termed doctrines, delivered with the most imposing apparatus of logical demonstration, but belied in almost every instance by experience, and affording us no assistance in the application of the powers of nature to the purposes of life. Nor will this excite much wonder in the mind of the enlightened reader of the present day, who reflects on the use that in this dialectic process was made of the categories, and the method in which those categories were formed. From first principles so vague in themselves, and so gratuitously assumed, ingenious men might deduce many different conclusions, all equally erroneous; and that this was actually done, no surer evidence can be given, than that hardly a lifetime elapsed when the whole system of doctrines which had captivated the minds of the most penetrating was oftener than once exploded and overturned by of n's so- y.

another system, which flourished for a while, and then was supplanted by a third, which shared the same fate. Here was an infallible proof of their error, for instability is incompatible with truth.

It is allowed by all that this has been the case in those branches of study at least which contemplate the philosophical relations of the material world; in astronomy, in mechanical philosophy, in chemistry, in physiology, in medicine, in agriculture. It is also acknowledged, that in the course of less than two centuries we have acquired much knowledge respecting these very subjects, call it philosophy, or by what name you will; so much more conformable to the natural course of things, that the deductions made from it by the same rules of the synthetic method are more conformable to fact, and therefore better fitted to direct our conduct and improve our powers. It is also certain that these bodies of doctrine which go by the name of philosophical systems have much more stability than in ancient times; and though sometimes in part superseded, they are seldom or never wholly exploded.

This cannot perhaps be affirmed with equal confidence respecting those speculations which have our intellect or propensities for their object: And we have not perhaps attained such a representation of human nature as will bear comparison with the original, nor will the legitimate deductions from such doctrines be of much more service to us for directing our conduct than those of ancient times; for whilst we observe this difference between these two general classes of speculations, we may remark, that it is conjoined with a difference in the manner of conducting the study. We have proceeded according to the old Aristotelian method when investigating the nature of mind; yet we see the material philosophers running about, passing much of their time away from books in the shop of the artisan, or in the open fields engaged in observation, labouring with their hands, and busy with experiments. But the speculatist on the intellect and the active powers of the human soul seems unwilling to be indebted to any thing but his own ingenuity, and his labours are confined to the closet. In the first class, we have met with something like success, and we have improved many arts; in the other, it is to be feared that we are not much wiser, or better, or happier, for all our philosophical attainments.

Here, therefore, must surely have been some great and fatal mistake. There has indeed been a material defect in our mode of procedure, in the employment of this method of reasoning as an inlet to truth. The fact is, that philosophers have totally mistaken the road of discovery, and have pretended to set out in their investigation from the very point where this journey should have terminated.

The Aristotelian logic, the syllogistic art, that art so much boasted of as the only inlet to true knowledge, and the only means of discovery, is in direct opposition to the ordinary procedure of nature, by which we every day, and in every action of our lives, acquire knowledge and discover truth. It is not the art of discovering truth; it is the art of communicating knowledge, and of detecting error: it is nothing more than the application of this maxim; "Whatever is true of a whole class of objects, is true of each individual of that class." This is not a just account of the art of discovering truth, nor is it a complete account of the art of reasoning. Reasoning is the producing of belief; and whatever mode of argumentation invariably and irresistibly produces belief, is reasoning. The ancient logic supposes that all the first principles are already known, and that nothing is wanted but the application of them to particular facts. But were this true, the application of them, as we have already observed, can hardly be called a discovery. But it is not true; and the fact is, that the first principles are generally the chief objects of our research, and that they have come into view only now and then, as it were by accident, and never by the labour of the logician. He indeed can tell us whether we have been mistaken; for if our general principle be true' it must influence every particular case. If, therefore, it be false in any one of these, it is not a true principle. And it is here that we discover the source of that fluctuation which is so much complained of in philosophy. The authors of systems give a set of consecutive propositions logically deduced from a first principle, which has been hastily adopted, and has no foundation in nature. This does not hinder the amusement of framing a system from it, nor this system from pleasing by its symmetry; and it takes a run: but when an officious follower thinks of making some use of it, which requires the comparison with experience and observation, they are found totally unlike, and the whole fabric must be abandoned as unsound; and thus the successive systems were continually pushing out their predecessors, and presently met with the same treatment.

View of Bacon's Philosophy.

How was this to be remedied? The ratiocination was seldom egregiously wrong; the syllogistic art had ere now attained a degree of perfection which left little room for improvement, and was so familiarly understood by the philosophical practitioners, that they seldom committed any great blunders. Must we examine the first principles? This was a task quite new in science; and there were hardly any rules in the received systems of logic to direct us to the successful performance of it. Aristotle, the sagacious inventor of those rules, had not totally omitted it; but, in the fervour of philosophical speculation, he had made little use of them. His fertile genius never was at a loss for first principles, which answered the purpose of verbal disquisition, without much risk of being belied on account of its dissimilitude to nature; for there was frequently no prototype with which his systematic doctrine could be compared. His enthusiastic followers found abundant amusement in following his example; and philosophy, being no longer in the hands of men acquainted with the world, conversant in the great book of nature, was now confined almost entirely to recluse monks, equally ignorant of men and of things. But curiosity was awakened, and the men of genius were fretted as well as disgusted with the disquisitions of the schools, which one moment raised expectations by the symmetry of composition, and the next moment blasted them by their inconsistency with experience. They saw that the best way was to begin *de novo;* to throw away the first principles altogether, without exception or examination, and endeavour to find out new ones which should stand the test of logic; or, in other words, should in every case be agreeable to fact.

The method of induction pointed out by nature.

Philosophers began to reflect, that under the unnoticed tuition of kind nature we have acquired much useful knowledge. It is therefore highly probable that her method is the most proper for acquiring knowledge, and that by imitating her manner we shall have the like success. We are too apt to slight the occupations of children, whom we may observe continually busy turning every thing over and over, putting them into every situation, and at every distance. We excuse it, saying that it is an innocent amusement; but we should rather say with an ingenious philosopher (Dr Reid), that they are most seriously and rationally employed; they are acquiring the habits of observation, and, by merely indulging an undetermined curiosity, they are making themselves acquainted with surrounding objects; they are struck by similitudes, and amused with mere classification. If some new effect occurs from any of their little plays, they are eager to repeat it. When a child has for the first time tumbled a spoon from the table, and is pleased with its jingling noise upon the floor, if another lie within its reach, it is sure to share the same fate. If the child be indulged in this diversion, it will repeat it with a greediness that deserves our attention. The very first eager repetition shows a confidence in the constancy of natural operations, which we can hardly ascribe wholly to experience; and its keenness to repeat the experiment shows the interest which it takes in the exercise of this most useful propensity. It is beginning the study of nature; and its occupation is the same with that of a Newton computing the motions of the moon by his sublime theory, and comparing his calculus with observation. The child and the philosopher are equally employed in the contemplation of a similarity of event, and are anxious that this similarity shall return. The child, it is true, thinks not of this abstract object of contemplation, but throws down the spoon again to have the pleasure of hearing it jingle. The philosopher suspects that the conjunction of events is the consequence of a general law of nature, and tries an experiment where this conjunction recurs. The child is happy, and eager to enjoy a pleasure which to us appears highly frivolous; but it has the same foundation with the pleasure of the philosopher, who rejoices in the success of his experiment; and the fact, formerly a trifle to both, now acquires importance. Both go on repeating the experiment, till the fact ceases to be a novelty to either; the child is satisfied, and the philosopher has now established a new law of nature.

Such, says this amiable philosopher, is the education of kind nature, who from the beginning to the end of our lives makes the play of her scholars their most instructive lessons, and has implanted in our mind the curiosity and the inductive propensity by which we are enabled and disposed to learn them. The exercise of this inductive principle, by which nature prompts us to infer general laws from the observation of particular facts, gives us a species of logic new in the schools, but as old as human nature. It is certainly a method of discovery; for by these means general principles, formerly unknown, have come into view.

Induction a just logic.

Induction is a just and rational logic; for it is founded on, and indeed is only the habitual application of, this maxim, that "Whatever is true with respect to every individual of a class of events, is true of the whole class." This is just the inverse of the maxim upon which the Aristotelian logic wholly proceeds, and is of equal authority in the court of reason. Indeed, the expression of the general law is only the abbreviated expression of every particular instance. This new logic, therefore, or the logic of induction, must not be considered as subordinate to the old system, or founded upon it. In fact, the use and legitimacy of the Aristotelian logic is founded on the inductive: All animals are mortal; all men are animals; therefore all men are mortal. This is no argument to any person who chooses to deny the mortality of men; for even although he acknowledges his animal nature, he will deny the major proposition.

It is beside our purpose to show how a point so general, so congenial to man, and so familiar, remained so long unnoticed, although the disquisition is curious and satisfactory. It was not till within these two centuries that the increasing demand for practical knowledge, particularly in the arts, made inquisitive men see how useless and insufficient was the learning of the schools in any road of investigation which was connected with life and business; and observe that society had received useful information chiefly from persons actually engaged in the arts which the speculatists were endeavouring to illustrate; and that this knowledge consisted chiefly of experiments and observations, the only contributions which their authors could make to science.

The *Novum Organum* of Bacon, which points out the true method of forming a body of real and useful knowledge, namely, the study of nature in the way of description, observation, and experiment, is undoubtedly the noblest present that science ever received. It may be considered as the grammar of nature's language, and is a counterpart to the logic of Aristotle; not exploding it, but making it effectual. (B. B. B.)

PHILOSTRATUS, Flavius, was an ancient Greek author. Eusebius calls him an Athenian, because he taught at Athens; but Eunapius and Suidas always speak of him as a Lemnian; and he himself hints, in his Life of Apollonius, that when he was young he used to reside at Lemnos. He frequented the schools of the sophists; and he mentions his having heard Damianus of Ephesus, Proclus Naucratitas, and Hippodromus of Larissa. This seems to prove that he lived in the reign of the Emperor Severus, from 193 to 212, when those sophists flourished. He afterwards became known to Julia Augusta, the wife of Severus, and was one of those learned men whom this philosophical empress had continually about her. It was by her command that he wrote his celebrated Life of Apollonius Tyanensis, as he relates himself in the same place where he informs us of his connections with that learned lady. Philostratus, as Cyril observes, endeavours to represent Apollonius as a wonderful and extraordinary person, rather to be admired and adored as a god, than to be honoured or considered as a mere man. Hence Eunapius, in the preface to his Lives of the Sophists, says that the proper title of that work should have been, The Coming of a God to Men; and Hierocles, in his book against the Christians, called Philalethes, and which was refuted by Eusebius in a work still extant, amongst other things instituted a comparison between Apollonius and Jesus Christ. It has always been supposed that Philostratus composed his work with a view to discredit the miracles and doctrines of our Lord, by setting up other miracles and other doctrines against them; and this supposition may be true: but that Apollonius was really an impostor and magician may not be so certain. He may, for ought we know, have been a wise and excellent person; and it is remarkable that Eusebius, though he had the worst opinion of the history of Philostratus, says nothing unfavourable of Apollonius. He concluded that that history was written to oppose the history of Jesus; and the use which the ancient infidels made of it justifies his opinion: but he draws no information from it with regard to Apollonius. It would have been improper to do so, since the sophistical and affected style of Philostratus, the sources whence he owns that his materials were drawn, and, above all, the absurdities and contradictions with which he abounds, plainly show that his history was nothing but a collection of fables, either invented, or at least embellished, by himself.

The works of Philostratus, however, have engaged the attention of some critics of the first class. Grævius intended to have given a correct edition of them, as appears from the preface of Meric Casaubon to a dissertation upon an intended edition of Homer, printed at London in 1658, 8vo. So also had Bentley, who designed to add a new Latin version of his notes; and Fabricius says that he saw the first sheet of Bentley's edition printed at Leipzig in 1691. Both these designs, however, were dropped. But a very exact and beautiful edition was at length published at Leipzig, 1709, in folio, by Olearius, professor of the Greek and Latin languages in that university; a man who has proved himself perfectly qualified for the work he undertook, and shown all the judgment, learning, and industry, which are required in an excellent editor.

At the end of the Life of Apollonius, there are ninety-five letters which go under his name. They are not, however, believed to be his, the style of them being very affected, and like that of a sophist, whilst they bear in other respects all the marks of a forgery. Philostratus says that he saw a collection of the Letters of Apollonius in Hadrian's library at Antium, but had not inserted them all amongst these. They are short, and have in them little else than moral sentences. The Lives of the Sophists contain many things which are to be met with nowhere else. The Heroics of Philostratus are only a dialogue between a vintner of the Thracian Chersonesus and a Phœnician, in which the former draws characters of Homer's heroes, and represents several things differently from that poet; and this is done upon the faith of Protesilaus's ghost, who had lately visited his farm, not far from the tomb of this hero. Olearius conjectures, with much probability, that Philostratus's design in this dialogue was secretly to criticise some things in Homer, which he durst not do openly, on account of the great veneration then paid to him, and for fear of the odium which Zoilus and others had incurred by censuring him too freely. The images are elegant descriptions and illustrations of some ancient paintings and other particulars relating to the fine arts, to which Olearius has subjoined the description of some statues by Callistratus, for the same reason that he subjoined Eusebius's book against Hierocles to the Life and Letters of Apollonius, namely, because the subjects of these respective works are related to each other. The last piece is a collection of Philostratus's Letters; but some of these, though it is not easy to determine which, were written by a nephew of Philostratus, of the same name, as were also the last eighteen in the book of images. This is the reason why the title runs not *Philostrati*, but *Philostratorum quæ supersunt omnia*. There were many persons of the name of Philostratus amongst the ancients; and there were many other works of the Philostratus here recorded, but no others are extant except those we have mentioned.

PHILOXENUS, a celebrated dithyrambic poet, a native of the island of Cythera, flourished B. C. 398, being contemporary with Timotheus and Telestes, and died at the age of sixty, B. C. 380. He was a son of Euletidas, and, when Cythera was taken by the Lacedæmonians, he was carried off as a slave. He was sold to Hegesylus, and on his death was bought by the poet Melanippides, by whose instruction he seems to have profited. He was devoted to the pleasures of the table, and became a great favourite of the elder Dionysius. Amongst various anecdotes told of him, it is said that Dionysius once repeated some of his own poetry to him, and asked his opinion of it, when the poet boldly told him that it was mere trash. The tyrant ordered him to prison, but at the solicitation of his friends released him the following day, and invited him to supper. He again repeated some poetry; but when Philoxenus was asked his opinion, he simply said, "Order me again to prison;" and arose, in expectation of being led away; but the tyrant was amused at the idea, and forgave him. Philoxenus, however, took an early opportunity of leaving Syracuse, and retired to Tarentum, which no solicitation of the tyrant could induce him to leave. According to another statement, he was so long confined in prison, that he had time to write a poem entitled Cyclops, which is said to have been one of the finest of his productions. Alexander the Great was a great admirer of the dithyrambics of Philoxenus and Telestes.

PHILTER, or PHILTRE (*philtrum*), in *Pharmacy* or *Chemistry*, a strainer. This term is also used for a drug or preparation, which, it is pretended, will excite love. The word is formed from the Greek φιλεω, *I love*, or φιλος, *lover;* because philters were given by the Greeks and Romans to excite love. Many grave authors believe the reality of these philters, and allege various facts in confirmation of their sentiments.

PHILYRA, in fabulous history, was one of the Oceanides, whom Saturn met in Thrace. The god, to escape from the vigilance of Rhea, changed himself into a horse, and by Philyra had a son half a man and half a horse, called Chiron. Philyra was so ashamed of having given birth to such a monster, that she entreated the gods to change her nature; and she was accordingly metamorphosed into a tree, called by her name amongst the Greeks.

PHINEHAS, or, as the Jews pronounce it, PINEHAS, was the son of Eleazar, and the grandson of Aaron. He was the third high priest of the Jews, and discharged this office from the year of the world 2571 till towards the year 2590. He appears in Scripture chiefly as distinguished by pious zeal for the faithful discharge of his duty, and for the divine glory. Two of his actions are commemorated as more particularly worthy of notice in this respect. The former of these events occurred during the high priesthood of his father Eleazar, and whilst he himself was second priest. The circumstances connected with it, and of which a full account is given by Moses (Numb. xxv. 7, ff.), were briefly these: Balaam, a famous soothsayer, having been brought by Balak, king of Moab, to curse the Israelites, but having by a mysterious influence been compelled to bless them, willing nevertheless to please his patron, and to earn "the wages of unrighteousness," suggested to the king the expedient of seducing the Israelites to idolatry, as the most likely mode of withdrawing from them the protection and favour of God. The expedient unhappily proved successful. Attracted by the license that prevailed at the celebration of the heathen festivals, the people of Israel joined in the sacrifices, and indulged in the loose and immoral practices of the Moabites. As an expression of the divine indignation against this conduct, God, in addition to a destroying plague which he sent amongst the people, commanded the judges of Israel to "slay every one his men that were joined to Baal-peor." To this command Phinehas was the first to render obedience. One of the princes of Israel, a man of great influence in the tribe of Simeon, Zimri by name, having audaciously, in this madness of sinful indulgence, conveyed a Moabitish female of high rank through the very midst of the camp of the Israelites, thereby offering outrage to the virtue and piety of those who were lamenting over the transgressions of the people, insulting in the most direct manner the majesty of God, and ostentatiously uttering defiance of the threatened punishment, Phinehas, stirred with a holy indignation, rushed from the midst of those who in horror and consternation had beheld the daring offence, and, following the guilty prince to his tent, transfixed him and his paramour in the midst of their licentious indulgence, and killed them both with one blow. For this act of valour, decision, and zeal, the plague was removed, and Phinehas was rewarded by having renewed to him that "covenant of peace," "the covenant of an everlasting priesthood," which God had on former occasions made with Noah, Abraham, and others distinguished for piety and zeal. Some have erroneously supposed that the blessing conferred upon Phinehas was the perpetuation in his family of the high priesthood of the Jews, and they have been not a little puzzled to account for the fact, that this office nevertheless passed out of his family after the death of Eli, at a period not very far removed from that here referred to. The mistake, however, must be obvious to all who have observed carefully the language of Scripture in regard to what is called God's covenant. By that term is designated the covenant of grace, "the everlasting covenant," which, the apostle tells us, was sealed with the blood of Christ (Heb. xiii. 20). This covenant God made with Adam after the fall; and he renewed it with particular individuals, in token of his approbation of their conduct, from time to time, until it was consummated in Christ; and it was by such a renewal of it with Phinehas that he expressed his commendation of the zeal which that individual showed in the case above related. With this, his occupying the place of high priest had no connection, as to that he succeeded by right of birth on the death of his father.

The other memorable action of Phinehas, in which he showed his zeal for the Lord, is recorded in Josh. xxii. 9–34. This was when the Israelites who were beyond Jordan had raised upon the banks of this river a vast heap of earth in the form of an altar. Those on the other side, fearing that they were going to forsake the Lord, and set up another religion, deputed Phinehas and other chief men amongst them to go and inform themselves of the reason of erecting this monument. But when they had found that it was in commemoration of their union and common original, Phinehas took occasion to praise the Lord, saying, "We perceive that the Lord is among us, because ye have not committed this trespass against the Lord."

We do not exactly know the time of the death of Phinehas. But as he lived after the death of Joshua, and before the first servitude under Chushan-rishathaim, during the time that there were neither kings nor judges in the land, and every one did that which was right in his own eyes (Judges, xvii. 6, xviii. 1, xxi. 24), his death is placed about the year of the world 2590. It was under his pontificate that the story of Micah happened, as also that of the tribe of Dan, when they made a conquest of Laish; and the enormity which was committed upon the wife of the Levite of the mountain of Ephraim (Judges, xx. 28). Phinehas's successor in the high priesthood was Abiezar, or Abishuah.

The Rabbin allow a very long life to Phinehas. There are some who believe that he lived to the time of the high priest Eli, or even to that of Samson. Others will have it that he was the same as Eli, or rather as the prophet Elias, which would still prolong his life for several ages.

PHLEBOTOMY, the opening of a vein with a proper sharp-edged and pointed instrument, to let out a certain quantity of blood, either for the preservation or recovery of a person's health. See SURGERY.

PHLEGON, a Greek historian, was a native of Tralles, in Lydia, and the freedman of the Emperor Hadrian (A. D. 117–138); and he is said to have published under his own name some works which were really the production of the emperor. He was the author of a history or chronicle, in sixteen books, which ended A. D. 141; and the loss of this work is the more to be regretted, as it would have probably furnished us with some curious information respecting the early times of the Christian church. A small fragment, entitled *De Olympiis*, on the origin and institution of the Olympic games, still remains; and in this work he notices the eclipse or wonderful darkness which occurred at the death of our Saviour. We have also two other works; *De Longævis libellus*, in which he mentions a certain Faustus, aged 136, who was presented to the emperor; and *De Rebus Mirabilibus liber*, a collection of popular stories, and prodigies performed at Delphi, which are narrated by those who had been eye-witnesses. These fragments have been frequently published, but the edition of Bast (Halle, 1822, 8vo) includes all the valuable annotations of his predecessors.

PHLOGISTON, a term employed by chemists to denote a principle which was supposed to enter into the composition of various bodies. The bodies which were thought to contain it in the largest quantity are such as are inflammable; and the property which these substances possess of being susceptible of inflammation was thought to depend upon this principle, so that it was sometimes called the Principle of Inflammability. Inflammation, according to this doctrine, was the separation of this principle, or phlogiston, from the other matter which composed the combustible body. As its separation was always attended with the emission of light and heat, some chemists thence concluded that it was light and heat combined with other matter in a peculiar manner, or that it was some highly elastic and very subtile matter, upon certain modifications of which heat and light depended. Another class of bodies which were supposed to contain phlogiston were the metals; and the chemists supposed that the peculiar lustre of the metals depended on this principle. Of this they thought themselves convinced by the evidence of their senses in two ways; first, because by exposing a metal to the action of a long-continued heat, it lost its metallic lustre, and was converted into an earthy-like substance called *calx metallicus*, or oxide; and, secondly, because by mixing this oxide with any inflammable substance whatever, and subjecting the mixture to certain operations, the inflammable matter disappeared, and the metal was restored to its former condition and lustre, without suffering much diminution in quantity, especially if the processes had been conducted with care and attention.

This fact relative to the metals was thought to be a full demonstration of itself, independently of other proofs which were brought to support the doctrine. These were, that a combustible body, by the act of inflammation, that is, by the dissipation of its phlogiston in the form of heat and light, was converted into a body which was no longer combustible, but which might have its property of combustibility restored to it again by mixing the incombustible remains with any kind of inflammable matter, and submitting the mixture to certain processes. In this way the body was restored to its former state of inflammability.

They were also at some pains to prove that the phlogiston, or the principle of inflammability, was the same in all inflammable bodies, and also in the metals. This identity of phlogiston they thought to be evident from the fact, that the calx of a metal might be restored to its metallic state, or that the remains after the combustion of a combustible body might be restored to its original state of combustibility by the addition of any inflammable body whatever, taken either from the animal, the vegetable, or the mineral kingdoms.

These and several other facts were brought to prove, not only the existence of phlogiston, but its effects in mixture with other substances; and the objections which were made against the doctrine were removed with wonderful ingenuity. The chief objection against it was, that if the inflammation of a combustible body, or the conversion of a metal into calx, depends upon the dissipation or extrication of phlogiston, then it must follow, that the remains of a combustible body after inflammation, and the calx of the metal, must be less than the matter from which they were produced. But this is contrary to fact, for when we collect with care all the vapour into which the purest inflammable bodies are converted by combustion, these incombustible remains are much heavier than the inflammable body from which they were produced, and the calx into which a metal is converted by long exposure to the action of heat is heavier than the metal from which it was produced. This consideration made several people doubt of the truth of the doctrine; but the objection was removed by saying, that phlogiston was so subtile, as not only to have no weight, but to possess an absolute levity; and that when it was taken from an absolutely heavy body, that body must, by losing so much absolute levity, become heavier, in the same manner as the algebraists say that a positive quantity is augmented by the subtraction of a negative quantity. This sophism satisfied the minds of most of the chemists, especially those who were algebraists.

The opinion that phlogiston was heat and light somehow combined with other matter, was proved, not only by the fact that heat and light were emitted from a combustible body during its combustion, but from the reduction of certain metallic calces to the original metallic state again, at least in some degree, by simple exposure to heat and light. The white calx of silver, for instance, when exposed in closely-sealed glass vessels to the light and heat of the sun, resumes a black tinge, and is in part restored to its metallic lustre, without any addition whatever; but then this restoration, like the others above mentioned, is attended with a loss of weight.

Besides constituting the principal portion of inflammable bodies and metals, phlogiston was thought to be the cause of colour in all vegetable and animal substances. This was concluded from the fact of plants growing white when defended from the action of the sun's rays, and having their green colour restored by fresh exposure to the light; and so far did the chemists suffer themselves to be deceived, that they actually thought the green colouring matter, which they extracted from fresh plants by certain chemical processes, to be an inflammable substance. But a very material objection was made to this argument. If plants owe their colour to phlogiston imparted by the sun's rays, why do the sun's rays destroy vegetable colours which are exposed to them? We know that the sun's rays are very effectual in diminishing the lustre of cloth dyed with vegetable colours, and in bleaching or taking out various stains from linen and other substances. All this, however, was removed by saying, that the sun's rays possessed different powers on living and on dead vegetable matter, and that the living vegetables had the power of absorbing phlogiston from the sun's rays, which dead vegetable matter had not.

Since the existence of phlogiston, as a chemical principle in the composition of certain bodies, has now been fully proved to be false, we shall not trouble our readers with any further observations on it, except to add, that although the chemists were satisfied with the proofs they gave of its reality, they were never able to exhibit it in a separate state, or show it in a pure form, unmixed with other matter.

From the time of Sir Isaac Newton till the middle of the eighteenth century, no real improvement was made in scientific chemistry; and the progress this science has made since that period is owing to the important discovery of the existence of heat in a state of composition with other matter. Heat thus combined loses its activity, or becomes insensible, just in the same way as any other active substance loses its apparent qualities in composition. Acids, for example, when combined in a certain proportion with substances for which they have strong attraction, as alkalies or absorbent earths, lose all their obvious acid qualities, and the compound turns out mild, and totally conceals the acid which it contains. In a similar manner, heat, when combined in certain proportions with other matter, loses its sensible qualities, and the compound conceals the heat which it contains. Heat, in this combined state, was denominated by its ingenious discoverer, Dr Black, *latent;* and it was found to be very abundant in the atmosphere, which owes its existence as an elastic fluid to the quantity of latent heat that it contains. After this discovery was made, Dr Crawford, considering that air was absorbed by a burning body, concluded that the heat which appears in the combustion of a combustible body, is the heat that had before existed in the air which was consumed by the burning body. M. Lavoisier and others, prosecuting this inquiry, found that the combustible body, whilst it is burning, unites with the basis of the air, and that the heat which the air contained, and which was the cause of the air existing in the state of air, is expelled. This absorption of the basis of the air by the burning body, and the reduction of this basis to a solid form, accounts for the increase of weight which a body acquires by burning; or, in other words, gives a reason why the matter into which a combustible body is converted by combustion, is heavier than the body from which it was produced. The same absorption of air is observable when a metal is converted into a calx, and the additional weight of the calx is found to be precisely equal to the weight of the air absorbed during the calcination. On these principles, therefore, we now explain the phenomena in a much more satisfactory manner than by the supposition of phlogiston, or a principle of inflammability.

PHOCÆA, the most northern of the cities of Ionia, was situated on the coast, about two hundred stadia from Smyrna. It was founded by a colony of Phocians, led by two Athenians, Philogenes and Damon, and was not admitted into the Ionian confederacy till it had received, from Teos and Erythræ, kings of the race of the Codridæ. Its citizens are said to have been the first amongst the Greeks who extended their voyages to great distances; in fact, the Adriatic, Tuscany, and even Tartessus, were visited in pursuit of commercial speculations. After the conquest of Crœsus, Cyrus sent his general Harpagus to reduce the Greek cities of Ionia, and the Phocæans abandoned their city rather than submit to the Persian yoke, B. C. 544. Some of them returned, but the greater part eventually settled in Italy, and founded the city of Velia. Phocæa, however, must still have continued to exist, as it furnished three ships in the Ionian revolt. Livy describes the city as standing at the bottom of a bay, and as being of an oblong shape. It enclosed a space of two miles and a half in length, and then contracted on both sides into a narrow wedge-like form, which place they called Lampter, or the lighthouse. It had two excellent harbours; the one towards the south was called Naustathmos, and the other was situated close to Lampter. It was taken and plundered by the Romans in the war against Antiochus. Phocæa founded Massilia, and Attalia in Corsica. The site is still called *Palaio Fokia.*

PHOCION, a very celebrated Athenian general, was descended from a family which at no time had been particularly distinguished in the political transactions of their country. He was born B. C. 402, and died B. C. 317, at the age of eighty-five. His early years were spent under the direction of Plato and Xenocrates, and his subsequent career showed that he had profited by their instruction. His aspect was forbidding, though his disposition was mild and gentle. It was remarked, that he was never seen to laugh or to weep. He commenced his military career under Chabrias, and gained so much influence with that general that he directed many of his proceedings. The victory at Naxos, B. C. 376, was in a great measure due to his prudence and military talents; nor was he less distinguished as a statesman and orator. He was quick in perception, and ready in debate, so that Demosthenes feared him more than any other orator, and is said to have called him the *Hatchet.* Phocion was aware of the true position of his country, knowing that she could no longer maintain that predominating influence which she had possessed during the last century. Peace was therefore the true policy of Athens, and he at all times advocated such a course of conduct. Yet, though his sense of the true interests of his country led him to be the promoter of peace, he was at all times ready to assist with his military talents. He commanded in the expedition, B. C. 350, against Eubœa, and gained the battle of Jamynæ. When Philip king of Macedonia laid siege to Byzantium, and the cities along the coast, Phocion relieved these cities from all danger, and compelled Philip to retire. At the head of his army he endured all the fatigues of the lowest of his soldiers; and when he appeared more warmly dressed than usual, the soldiers used to consider it the sign of a severe winter. He was a man of the strictest integrity; and, at a time when few of the orators and statesmen of Athens were able to resist the temptation of enriching themselves at the expense of their country, Phocion remained poor, and refused all the offers of the Macedonian kings. He was, of course, opposed to the policy of Demosthenes, and employed all his influence to thwart his measures. In the troubles which followed the death of Alexander, he was favourable to the party of Antipater; and when Polysperchon re-established the popular form of government, Phocion was seized, and being brought before an assembly, Phocis.

composed chiefly of slaves and strangers, he was condemned to die. He was put to death in his eighty-fifth year.

PHOCIS, a country of Greece, contained between Bœotia in the east and Locris in the west, but extending formerly from the *Sinus Corinthiacus* on the south to the Sea of Eubœa on the north, and, according to Dionysius, as far as Thermopylæ; though it was reduced afterwards to narrower dimensions. The *Phocenses* were the people of Phocis, and *Phocicus* was the epithet; thus *Bellum Phocicum* means the sacred war which the Thebans and Philip of Macedonia carried on against them for plundering the temple at Delphi, and by which Philip paved the way to the sovereignty of all Greece. The greatest length of Phocis was from north to south, that is, from 38. 45. to 39. 20., or about thirty-five miles; but it was very narrow from east to west, not extending to thirty miles, that is, from 23. 10. to 23. 40. at the widest, but about twenty-three miles towards the Corinthian bay, and still narrower towards the north. This country is generally allowed to have taken its name from Phocus the son of Ornytion, a native of Corinth; but having been soon afterwards invaded by the Eginetæ, under the conduct of another Phocus, the son of Eacus king of Enopia, the memory of the first insensibly gave way to that of the second.

In Phocis there were several very celebrated mountains, such as Cythæron, Helicon, and Parnassus. Cythæron was consecrated to the muses, as were also the other two, and it was consequently much celebrated by the poets. Both it and Helicon contend with Parnassus for height and magnitude. There were no remarkable rivers in Phocis except the Cephisus, which runs from the foot of Parnassus northwards, and empties itself into the Pindus, which was near the boundary of the kingdom. It had several very considerable cities, such as Cirrha, Crissa, and Antecyra, which, according to Ptolemy, were situated on the sea coasts; and Pythia, Delphi, Daulis, Elatia, Ergosthenia, and Baulia, which were inland towns. Elatia was the largest and richest after Delphi.

Deucalion was king of that part of Phocis which lies near Parnassus, at the time when Cecrops flourished in Attica; but the Phocians afterwards formed themselves into a commonwealth, governed by their general assemblies, the members of which were chosen from amongst themselves, and changed as often as occasion required. Of the history of the Phocians but little is known until the time of the holy war, of which the following account is given in the Ancient Universal History.

"The Phocians having presumed to plough the territories of the city of Cirrha, consecrated to the Delphic god, were summoned by the other Grecian states before the court of the Amphictyons, where a considerable fine was imposed upon them for their sacrilege. They refused to pay it, on pretence that it was too large; and at the next assembly their dominions were adjudged confiscated to the use of the temple. This second sentence exasperated the Phocians still more; who, at the instigation of one Philomelus, or, as he is called by Plutarch, Philomedes, seized upon the temple, plundered it of its treasure, and held the sacred depositum for a considerable time. This second crime occasioned another assembly of the Amphictyons, the result of which was a formal declaration of war against the Phocians. The quarrel being become more general, the several states took part in it, according to their inclinations or interest. Athens, Sparta, and some others of the Peloponnesians, declared for the Phocians; and the Thebans, Thessalians, Locrians, and other neighbouring states, against them. A war was commenced with great fury on both sides, and styled *the holy war*, which lasted ten years; during which the Phocians, having hired a number of foreign troops, made an obstinate defence, and would in all probability have held out much longer had not Philip of Macedon given the finishing stroke to their total defeat and punishment. The war being ended, the grand council assembled again, and imposed an annual fine of sixty talents upon the Phocians, to be paid to the temple, and continued till they had fully repaired the damage it had sustained from them; and, till this reparation should be made, they were excluded from dwelling in walled towns, and from having any vote in the grand assembly. They did not, however, continue long under this heavy sentence. Their known bravery made their assistance so necessary to the rest, that they were glad to remit it; after which remission they continued to behave with their usual courage and resolution, and soon obliterated their former guilt."

Phocyli
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Phœni

PHOCYLIDES, a Greek poet, was a native of Miletus, in Ionia, and flourished B. C. 544, being the contemporary of Theognis. He was the author of some epic poems and elegies; but, of all his works, only a poem (*Carmen Nutheticon*), of two hundred and seventeen verses, has been preserved. As it is only alluded to by an ancient scholiast on Nicander, there is some doubt if it be really the production of Phocylides, as none of the passages quoted by Plato, Aristotle, Strabo, and other writers, are to be found in any part of this poem. It is published in all the editions of the *Sententiæ* of Theognis; but the most valuable one is that by J. A. Schier, with a Latin translation, and learned annotations, Leipzig, 1751, 8vo.

PHŒBUS, one of the names applied by the ancient mythologists to the Sun, Sol, or Apollo.

PHŒNICIA, or more properly PHŒNICE, the ancient name of a country situated between the thirty-fourth and thirty-sixth degrees of north latitude, being bounded by Syria on the north and east, by Judæa on the south, and by the Mediterranean on the west. How it obtained its name is not certainly known. Some derive it from one Phœnix; and others from the Greek word *phœnix*, signifying a *palm* or *date*, as that tree abounded in the country. Some suppose that Phœnice was originally a translation of the Hebrew word *Edom*, from the Edomites who fled thither in the days of David. By the contraction of the word *Canaan* it was also called *Chna*, and anciently *Rhabbothin* and *Colpitis*. The Jews commonly named it *Canaan;* though some part of it, at least, was known to them by the name of *Syrophœnice*. Bochart tells us, that the most probable etymology is *Phene Anak*, the descendants of Anak. Such were the names peculiar to this small country, though Phœnice was sometimes extended to all the maritime countries of Syria and Judæa, and Canaan to that of the Philistines, and even of the Amalekites. On the contrary, all these names were superseded by those of Palestine and Syria.

There is some disagreement amongst authors respecting the northern limits of this country. Ptolemy states the river Eleutherus as the boundary of Phœnice to the north; but Pliny, Mela, and Stephanus, place it in the island of Aradus, to the northward of that river. Strabo observes, that some considered the river Eleutherus as the boundary of Seleucis, on the side of Phœnice and Cœlesyria. On the coast of Phœnice, and south of the river Eleutherus, stood the cities of Simyra, Orthosia, Tripolis, Botrys, Byblus, Palæbyblus, Berytus, Sidon, Sarepta, Tyrus, and Palætyrus.

According to Ptolemy, Phœnice extended even beyond Mount Carmel; for that geographer places in Phœnice not only Ecdippa and Ptolemais, but Sycaminum and Dæra, which are situated to the southward of that mountain. But these towns, properly speaking, belonged to Palestine. We will not take upon us to mark out the bounds of the midland Phœnice. Ptolemy reckons in it the towns of Arca, Palæbyblus, Gabala, and Cæsaria Paniæ. This province was considerably extended in the early times of Christianity, when, being considered as a province of Syria, it included not only Damascus, but also Palmyra.

The Phœnicians were governed by kings; and their territory, small as it was, included several kingdoms, namely, those of Sidon, Tyre, Aradus, Berytus, and Byblus. In this particular they imitated and adhered to the primitive government of their forefathers, who, like the other Canaanites, were under many petty princes, to whom they allowed the sovereign dignity, reserving to themselves the natural rights and liberties of mankind. Of their civil laws no remnant has been preserved.

With regard to religion, the Phœnicians were the most gross and abominable idolaters. The Baal-berith, Baalzebub, and Baal-samen, mentioned in Scripture, were some of the Phœnician gods; as were Moloch, Ashtaroth, and Thammuz, also mentioned in the sacred writings. The word *Baal*, in itself an appellative, was no doubt applied to the true God, until he rejected it on account of its being so much profaned by the idolaters. The name was not appropriated to any particular deity amongst the idolatrous nations, but was common to many; it was generally imagined, however, that one supreme God presided over all the rest. Amongst the Phœnicians this deity was named *Baal-samen*, but the Hebrews would have called him *Baal-shemim*, or the God of heaven. In all probability this was also the principal Carthaginian deity, although his Punic name is unknown. Many religious rites of the Carthaginians have been handed down to us by the Greek and Roman writers; but they all bestowed the names of their own gods upon those of the Carthaginians, a circumstance which leads us to a knowledge of the correspondence between the characters of the Phœnician and the European deities. The principal deity of Carthage was, according to Diodorus Siculus, Chronos or Saturn; and the sacrifices offered up to him were children of the best families. We also learn, that the Carthaginians had a brazen statue or colossus of this god, the hands of which were extended in the act of receiving, and bent downwards in such a manner that the child laid thereupon immediately fell down into a hollow where there was a fiery furnace. It is added, that this inhuman practice seemed to confirm a tradition handed down to the Greeks from remote antiquity, that Saturn devoured his own children.

The goddess Cœlestis, or Urania, was held in the highest veneration by the Carthaginians. She is supposed to have been the same with the queen of heaven mentioned in Jeremiah, or the Juno Olympia of the Greeks. According to Hesychius, the same word, in the Punic language, was applied both to Juno and Venus; nay, the ancient Greeks frequently confound Juno, Venus, and Diana or the moon, which is to be attributed to the Egyptians and Phœnicians, from whom they received their system of religion, and who in the most ancient times appear to have had but one name for them all. Besides these there were several other deities, who were worshipped amongst the Phœnicians, particularly those of Tyre, and consequently amongst the Carthaginians. These were Jupiter, Apollo, Mars, and Bacchus. Jupiter was worshipped under the name of *Belus* or *Baal;* to him they addressed their oaths; and his name they placed at the head of their treaties. Apollo or the Sun went either by this name simply, or by others of which it formed a part.

The Carthaginian superstition, however, was not confined to these deities alone. They worshipped the fire, the air, and the other elements, and had a multitude of local gods. Nay, they paid divine honours to the spirits of their heroes, and even to men and women whilst yet in life; and in this adoration Hannibal had for some time a share, notwithstanding the infamous conduct which his countrymen showed towards him at last. In order to worship these gods with more convenience, the Carthaginians had a kind of portable temples. These were covered chariots, in which were small images representing their favourite deities, and which were drawn by oxen. They served also as a kind of oracle, and their responses were understood by the motion impressed upon the vehicle. The tabernacle of Moloch is supposed to have been a machine of this kind; and it is not probable that the whole was derived from the tabernacle of the Jews in the wilderness.

Besides all the deities above mentioned, we find another, named the *Dæmon* or *Genius* of Carthage, which is mentioned in the treaty made by Philip of Macedonia and Hannibal. What this deity was we know not; but it may be observed, that the pagan world in general believed in the existence of dæmons, or intelligences who had a kind of middle nature between gods and men, and to whom the administration of the world was in a great measure committed. Hence it is no wonder that they should have received religious honours; for when once mankind were possessed with the opinion that they were the ministers of the gods, and trusted with the dispensation of their favours, as well as the infliction of their punishments, it is natural to suppose that they would be desirous of making their addresses to these beings.

Much has been said of their arts, sciences, and manufactures; but as all that we find concerning them is couched in general terms, we cannot enter into particulars. The Sidonians, under which denomination we comprehend the Phœnicians in general, were a people of most happy genius. They were from the beginning addicted to philosophical exercises of the mind; insomuch that a Sidonian, by name Moschus, taught the doctrine of atoms before the Trojan war, and Abomenus of Tyre puzzled Solomon by the subtilty of his questions. Phœnice continued to be one of the seats of learning, and in later times both Tyre and Sidon produced their respective philosophers; namely, Boethus and Diodatus of Sidon, Antipater of Tyre, and Apollonius of the same place, who gave an account of the writings and disciples of Zeno. As to their manufactures, the glass of Sidon, the purple of Tyre, and the fine linen they wove, were the products of their own country, and their own invention; and for their extraordinary skill in working metals, in hewing timber and stone, and their perfect knowledge of what was solid, great, and ornamental in architecture, we need only remind the reader of the large share which they had in erecting and decorating the temple at Jerusalem under their king Hiram. Their fame for taste, design, and ingenious invention, was such, that whatever was elegant, great, or pleasing, whether in apparel, in vessels, or in toys, was distinguished by way of excellence by the epithet of Sidonian.

The Phœnicians were likewise celebrated merchants, navigators, and planters of colonies in foreign parts. As merchants, they may be said to have engrossed all the commerce of the western world; as navigators, they were the boldest, the most experienced, and the greatest discoverers of ancient times, and for many ages they had no rivals. In planting colonies they exerted themselves so much that, considering their territory was little more than the slip of land situated between Mount Lebanon and the sea, it is surprising how they could furnish such supplies of people, and not wholly depopulate their native country.

It is generally supposed that the Phœnicians were induced to deal in foreign commodities by their neighbourhood to the Syrians, who were perhaps the most ancient of those who carried on a considerable and regular trade with the nations farther to the east. And this conjecture appears at least probable; for their own territory was but small, and little able to afford any considerable exports, if we except manufactures; but that their manufactures were considerable until they began to turn all the channels of trade into their own country, it is difficult to believe. In Syria, which was a large country, they found store of productions of the natural growth of the soil, whilst many choice and useful commodities were imported from the East. Thus, having a safe coast, with convenient harbours on one side, and excellent materials for ship-building on the other; perceiving how acceptable many commodities which Syria furnished would be in foreign parts, and being stimulated by the example of the Syrians; they turned all their thoughts to trade and navigation, and by an uncommon application soon eclipsed their masters in that art.

It were in vain to discourse of the Edomites who fled hither in David's time, or to inquire why Herodotus supposed that the Phœnicians came from the Red Sea. That some of the Edomites fled into this country in the days of David, and that they were a trading people, is very evident; but what improvements they brought with them into Phœnice it is hard to say, and it is not less difficult to ascertain their numbers. In all probability they brought with them a knowledge of the Red Sea, and of the southern parts of Arabia, Egypt, and Ethiopia, and by their information made the Phœnicians acquainted with those coasts; and by these means the latter were enabled to undertake voyages to those parts, for Solomon, and Pharaoh-Necho, king of Egypt.

Their whole thoughts were employed about schemes for advancing their commerce. They affected no empire but that of the sea, and appeared to aim at nothing but the peaceable enjoyment of their trade. This they extended to all the known parts they could reach; to the British Islands, commonly understood by the Cassiterides; to Spain, and other places in the ocean both within and without the Straits of Gibraltar; and, in general, to all the ports of the Mediterranean, the Black Sea, and the Palus Mæotis or Sea of Azof. In all these parts they had founded settlements, whence they drew whatever was useful to themselves, or might prove so to others; and thus they enjoyed the three great branches of trade, as it is commonly divided into importation, exportation, and transportation. Such appears to have been their trade by sea; and as to that which they carried on by land in Syria, Mesopotamia, Assyria, Babylonia, Persia, Arabia, and even in India, it was not less extensive, and may give us an idea of what this people once was, and how deservedly their merchants are mentioned in Scripture as equal to princes. Their country was at that time the great warehouse, where every thing that could administer either to the necessities or luxury of mankind was to be found; and all this they distributed as they judged best for their own interest. The purple of Tyre, the glass of Sidon, and the fine linen made in this country, together with curious pieces of art in metals and wood, appear to have been the chief and almost only commodities of Phœnice itself. Indeed their territory was so small, that it is not to be imagined they could afford to export any products of their own growth.

Having thus spoken in general terms of the trade of the Phœnicians, we shall now touch upon their shipping, and some things remarkable in their navigation. Their larger vessels were of two sorts, being divided into round ships or gauli, and long ships, galleys, or triremes. When they drew up in line of battle, the gauli were disposed at a small distance from each other in the wings, or in the van and the rear; whilst their triremes were contracted together in the centre. If at any time they observed that a stranger kept them company in their voyage, or followed in their track, they were sure to get rid of him if they could, or deceive him if possible; and in this policy they went so far, as to venture the loss of their ships, and even their lives, so jealous were they of foreigners, and so tenaciously bent upon keeping the whole trade to themselves. To discourage other nations from engaging in commerce, they practised piracy, or at least pretended to be at war with such as they met when they thought themselves strongest. This was a natural stroke of policy on the part of a people who grasped at the whole commerce of the then known world. We must not forget to mention here the famous fishery of Tyre, which so remarkably enriched that city. The murex, or purple dye, has been celebrated by all the ancient writers.

PHŒNIX, the great palm or date-tree. There is only one species, viz. the *dactylifera*, or common date-tree, a native of Africa and the eastern countries, where it grows to fifty, sixty, and a hundred feet in height. The trunk is round, upright, and studded with protuberances, which are the vestiges of the decayed leaves. From the top issues forth a cluster of leaves or branches eight or nine feet long, extending all around like an umbrella, and bending a little towards the earth. The lower part produces a number of stalks like those of the middle, but these seldom shoot so high as four or five feet. The stalks, according to Adanson, diffuse the tree very considerably, so that, wherever it grows naturally in forests, it is extremely difficult to open a passage through its prickly leaves. The date-tree was introduced into Jamaica soon after the conquest of that island by the Spaniards. There are, however, but few of them in the island at the present time. The fruit is somewhat in the shape of an acorn. It is composed of a thin, light, and glossy membrane, somewhat pellucid and yellowish, which contains a fine, soft, and pulpy fruit, that is firm, sweet, and somewhat vinous to the taste, esculent, and wholesome; and within this is enclosed a solid, tough, and hard kernel, of a pale gray colour upon the outside, and finely marbled within like the nutmeg. For medicinal use dates are to be chosen large, full, fresh, yellow on the surface, soft and tender, not too much wrinkled; such as have a vinous taste, and do not rattle when shaken. They are produced in many parts of Europe, but never ripen perfectly there. The best are brought from Tunis; they are also very fine and good in Egypt, and in many parts of the East. Those of Spain and France look well; but they are never perfectly ripe, and very subject to decay. They are preserved three different ways; some pressed and dry; others pressed more moderately, and again moistened with their own juice; and others not pressed at all, but moistened with the juice of other dates, as they are packed up, which is done in baskets or skins. Those preserved in this last way are much the best. Dates have always been esteemed moderately strengthening and astringent.

Dates afford wholesome nourishment, and have a very agreeable taste when they are fresh; the Arabs, however, eat them without seasoning. They dry and harden them in the sun to reduce them to a kind of meal, which they lay up in store to supply themselves with food during the long journeys which they often undertake across their deserts. This simple food is sufficient to nourish them for a long time. The inhabitants of the Sahara also procure from their dates a kind of honey, which is exceedingly sweet. For this purpose they choose those which have the softest pulp; and having put them into a large jar with a hole in the bottom, they squeeze them by placing over them a weight of eight or ten pounds. The most fluid part of the substance, which drops through the hole, is what they call the honey of the date. Even the stones, though very hard, are not thrown away, but given to their camels and sheep as food, after they have been bruised or laid to soften in water.

Phœnix, in *Antiquity*, a famous bird, which is generally regarded by the moderns as fabulous. The ancients speak of this bird as single, or the only one of its kind. They describe it as of the size of an eagle, having its head finely crested with a beautiful plumage, its neck covered with feathers of a gold colour, and the rest of its body, except the tail, purple, and the eyes sparkling like stars. They hold that it lives five or six hundred years in the wilderness; that when thus advanced in age, it builds itself a pile of sweet wood and aromatic gums, which it fires with the wafting of its wings, and thus burns itself; and that from its ashes arises a worm, which in time grows up to be a phœnix. Hence the Phœnicians gave the name *phœnix* to the palm-tree, because, when burned down to the root, it rises again fairer than ever.

PHOLIS, an old name for gypsums or plaster-stones. It is derived from φολις, a *scale* or *small flake*, because these stones are composed of particles of that form.

PHONICS, the doctrine or science of sound, otherwise called acoustics. See ACOUSTICS.

PHORMINX, a stringed instrument used by the ancient Greeks, and probably by the Egyptians. Its nature is not known; but it is mentioned by Homer, Euripides, and others.

PHOSPHORUS, a name given to certain substances which shine in the dark without emitting heat. By this circumstance they are distinguished from the *pyrophori*, which, though they take fire on being exposed to the air, are yet entirely destitute of light before such exposure. Phosphori are divided into several kinds, known by the names of Bolognian phosphorus, Mr Canton's phosphorus, Baldwin's phosphorus, phosphorus of urine, and the like. The phosphorus of urine is by far the most remarkable, both with respect to the quantity of light which it emits, and its property of taking fire and burning very fiercely upon being slightly heated or rubbed.

PHOTINIANS, in *Ecclesiastical History*, were a sect of heretics in the fourth century who denied the divinity of our Lord. They derive their name from Photinus their founder, who was bishop of Sirmium, and a disciple of Marcellus. In the year 343 Photinus published his notions respecting the Deity, which were repugnant both to the orthodox and to the Arian systems. He asserted that Jesus Christ was born of the Holy Ghost and the Virgin Mary; that a certain divine emanation, which he called the Word, descended upon him; that, because of the union of the Divine Word with his human nature, he was called the Son of God, and even God himself; and that the Holy Ghost was not a person, but merely a celestial virtue proceeding from the Deity. Both parties condemned the bishop in the councils of Antioch and Milan, held in the years 345 and 347. He was also condemned by the council at Sirmium in 351, and having been degraded from the episcopal dignity, he died in exile in the year 372 or 375. His opinions were afterwards revived by Socinus.

PHOTINX, an ancient wind-instrument of Egypt, said to have been a kind of flute of a curved form. Several modern wind-instruments are curved.

PHOTIUS, patriarch of Constantinople, was one of the most remarkable men of his time, and by his merit raised himself to the patriarchate. When Bardas had driven Ignatius from the see, Photius was consecrated by Asbestus in 859. He condemned Ignatius in a synod, upon which the pope excommunicated him; and, to balance the account, Photius anathematized the pope. Basilius of Macedonia, whom Photius had reproved for the murder of the Emperor Michael, expelled him, and restored Ignatius; but afterwards, upon the death of Ignatius, Photius was re-established in the year 878. At last, being wrongfully accused of a conspiracy against the person of Leo the philosopher, son and successor of Basilius, he was expelled in 886, and is supposed to have died soon afterwards. He wrote a *Bibliotheca*, which contains an examination of two hundred and eighty authors; and we have also two hundred and fifty-three epistles of his, the *Nomocanon* under fourteen titles, and an abridgment of the acts of several councils. This great man was born in Constantinople, and descended from a very illustrious and noble family. His natural abilities were eminent, and he cultivated them with the greatest assiduity. There was no branch of literature, whether sacred or profane, and scarcely any art or science, in which he was not deeply versed. Indeed he appears to have been by far the greatest man of the age in which he lived; and he was so intimately concerned in the chief transactions of it, that ecclesiastical writers have on that account called it *Sæculum Photianum*. He was first raised to the chief dignities of the empire, being made principal secretary of state, captain of the guards, and a senator; and in all these stations he acquitted himself with a distinction suitable to his great abilities, having been an able statesman as well as a profound scholar. His rise to the patriarchate was very rapid; for when he was chosen to that office he was only a layman; but, that he might, as it were, be gradually raised to that dignity, he was made monk the first day, reader the next, and the following days sub-deacon, deacon, and priest, so that in the space of six days he attained to the highest office in the church. On the whole, however, his ardent love of glory and unbounded ambition led him to commit excesses which rendered him a scourge to those around him. Fabricius describes his *Bibliotheca*, or Library, as *non liber, sed insignis thesaurus*, not a book, but an illustrious treasure, in which are contained many curious things relating to authors, and many fragments of works which are nowhere else to be found. It was brought to light by Andreas Scottus, and communicated by him to David Hoeschelius, who caused it to be printed in 1601. Scottus, considering the great utility of this work, translated it into Latin, and printed his translation separately in the year 1606. The Greek text, together with the translation, was afterwards printed at Geneva in 1611.

PHOTOMETER, an instrument for ascertaining the intensity of light. See METEOROLOGY and OPTICS.

PHRASE, in *Grammar*, an elegant turn or manner of expression, peculiarly belonging to this or that occasion, this or that art, this or that language. Thus we say, an Italian *phrase*, an eastern *phrase*, a poetical *phrase*, a rhetorical *phrase*. Phrase is sometimes also used for a short sentence or small circuit of words constructed together. In this sense, Father Buffier divides phrases into complete and incomplete. Phrases are *complete* where there is a noun and a verb, each in its proper function; that is, where the noun expresses a subject, and the verb the thing affirmed of it. *Incomplete* phrases are those where the noun and the verb together only perform the office of a noun, and consist of several words, which, without affirming any thing, might be expressed by a single term. Thus, *that which is true*, is an incomplete phrase, and might be expressed in one word, *truth;* and again, *that which is true satisfies the mind*, might be converted into *truth satisfies the mind*.

PHRASEOLOGY, a collection of the phrases or the elegant expressions in any language.

PHREATIS, or PHREATTIUM, in Grecian antiquity, was a court belonging to the civil government of Athens, situated upon the sea-shore, in the Piræus. The name is commonly derived ἀπο του φρεατος, because it stood in a pit; or, as others suppose, it is formed from the name of the hero *Phreatus*. This court heard such causes as concerned persons who had fled from their own country for murder, or those who had fled for involuntary murder, and had afterwards committed a deliberate and wilful murder. The first who was tried in this place was Teucer, on a groundless suspicion that he had been accessory to the death of Ajax. The accused was not allowed to land, or so much as to cast anchor, but pleaded his cause in his bark, and if found guilty, he was committed to the mercy of the winds and waves, or, as some say, suffered there condign punishment; but if innocent, he was only cleared of the second fact, and, according to custom, underwent a twelvemonth's banishment for the former.

PHRENITIC, a term used to denote those who, without being absolutely mad, are subject to such strong sallies of imagination as in some measure pervert their judgment, and cause them to act in a way different from the more rational part of mankind.

PHRENOLOGY.

Definition.

PHRENOLOGY, derived from φρην, *the mind*, and λογος, *discourse*, is a term which has been recently applied to denote a new doctrine of mental philosophy, founded on a presumed knowledge of the functions of different portions of the brain, obtained by comparing their relative forms and magnitudes in different individuals, with the propensities and intellectual powers which these individuals are found respectively to possess. This term has of late years totally superseded the more unpretending titles of CRANIOLOGY and CRANIOSCOPY, by which this doctrine, in its earlier periods, and before it had aspired at effecting a revolution in psychology, was designated, and which simply implied the study of the external forms of the skull, both in men and animals, with a view to determine the size of the subjacent parts of the brain, and thence to derive indications as to the mental and moral qualities of each individual.

The original propounder of the doctrine which is the basis of phrenology was Dr. Gall, a physician of Vienna, whose system, matured in conjunction with Dr. Spurzheim, has attracted so much attention, and been so keenly discussed, both here and on the Continent, that we think it our duty to present our readers with a general outline of this pretended science.

Physiology of the brain imperfectly known.

Of the several parts which compose the human body, the mechanism of which has been so thoroughly unfolded by the diligence of modern anatomists, there are few whose use in the economy is wholly unknown. The intention and operation of every part of our frame subservient to the mechanical purposes of connexion, of locomotion, and of strength, such as the bones, muscles, and ligaments, are, in general, sufficiently apparent; the functions performed by the abdominal and thoracic viscera are, for the most part, well ascertained; and we are able, in like manner, to discern the adaptation of the organs of sense to receive appropriate impressions from surrounding objects. One organ alone, and an organ of vast importance in the system, connected with every other, and essentially interwoven with our sensitive existence, has baffled all investigation, and still presents a wide blank in this rich and cultivated field of knowledge. The brain, that large mass of pulpy substance, which fills the cavity of the cranium, is, even at the present day, as incomprehensible in its functions, as it is subtle and complex in its anatomy. It appears, indeed, to be sufficiently established, that the brain is, in some unknown way, subservient to sensation and voluntary motion, and is thereby the immediate agent by which the soul and body mutually exert an influence over each other: and it has also been very generally supposed, that this organ is immediately concerned in all our mental operations, besides being the instrument by which we feel and act. But the phenomena comprehended under the operations of the mind are exceedingly various and complicated, and are also of very different kinds; so that before we can reason concerning them, it is necessary that they should be properly distinguished and arranged. Metaphysicians have, accordingly, classed them as referable to our sentient, our intellectual, our active, and our moral powers. Further subdivision again is required; and the intellectual phenomena, for instance, are arranged according as they relate to the faculties of conception, association, memory, abstraction, judgment, imagination, invention, &c. Other phenomena are distributed under the heads of the different active principles, such as the propensities, the instincts, the affections, and the passions, which belong to our nature. Whilst we thus discover a great diversity in the functions of the mind, we observe also as great a complexity of structure in the organs by which they are performed. Shall we rest satisfied with an acquiescence in the general proposition, that the brain is the organ of thought? May we not rather regard it as a congeries of distinct organs, corresponding to the different faculties into which the mind may be analyzed; each organ having its appropriate office, and being immediately subservient to some particular function of the mind? The question has, indeed, presented itself to many physiologists; but few have ventured farther in attempting its solution, than to throw out some vague and general conjectures as to the uses of certain parts, or as to the supposed habitation of the sentient principle. Thus, for a long period it was held, that the cerebrum was the organ of perception, and the cerebellum the organ of memory. The cavities which are met with in the interior of the brain have often been considered as the scene of the intellectual operations. Nemesius, the first bishop of Emesa, under the reign of Theodosius, taught that the sensations had their seat in the anterior ventricles, memory in the middle, and understanding in the posterior ventricles. Albertus Magnus, in the thirteenth century, went so far as actually to delineate upon a head the supposed seat of the different faculties of the mind. He placed common sense in the forehead, or in the first ventricle of the brain, cogitation and judgment in the second, memory and moving power in the third. Peter de Montagnana, in 1491, published the figure of a head, on which were indicated the seat of the *sensus communis*, the *cellula imaginativa*, *cellula æstimativa seu cogitativa*, *cellula memorativa*, and *cellula rationalis*. Ludovico Dolci, Servito, and a great number of other writers, have hazarded similar hypotheses as to the locality of the different faculties. Both Haller and Van Swieten fancied that the internal senses occupy different places in the brain; but they considered its whole organization as too complicated, too intricate, and too difficult, to allow of any hope that the seat of memory, of judgment, or of imagination, could ever be detected.

Histor Dr. Ga speculations.

In the pursuit of this speculation, no one has engaged with more ardour and perseverance than Dr. Gall, who, after many years of patient labour, and much fruitless wandering in search of the truth, conceived that he had at last discovered the clue which was to conduct us through the mazes of this labyrinth, and enable us to arrive at a more accurate knowledge of human nature, and of the means which may conduce to its perfection. The account which he gave of the circumstances that gradually drew his attention to the subject, and of his progress in this new path of discovery, is as follows: Brought up in the midst of a numerous family, and naturally gifted with the talent for observation, he was struck, even when a boy, with the diversities of disposition and of character amongst his brothers and sisters, and the companions with whom he was educated. He remarked, that each excelled in a particular study, or was distinguished by a peculiar turn of mind. One was noted for the beauty of his handwriting; another for his quickness at arithmetic; a third for his aptitude in learning languages; a fourth for remembering everything that he read in history. This diversity was apparent in all that they did; thus the style of composition of the one was remarkable for its flowing and elegant periods; of another for its baldness and dryness; of a third for its condensation and vigour. Many displayed talents for arts which had never been taught them; they excelled, perhaps, in drawing, or in the execution of works of mechanism; some sought for amusement in noisy sports, others preferred cultivating their gardens; a few placed their chief delight in rambling through fields and forests, and in collecting birds, insects, and flowers. One was of a social and affectionate disposition, another was selfish and reserved; a third was fickle, and not to be depended upon. The great facility with which some of his school-fellows could commit their tasks to memory, which to him was a work of immense labour, although in matters of reasoning and judgment he felt himself their superior, often proved a grievous source of mortification, and excited in him a strong desire to know the cause of this difference. He at length remarked, that all the boys gifted with this kind of memory had large and prominent eyes. He afterwards went to the university; and directing his attention to all those among his fellow-students, who presented the same peculiarity of feature, he learned that they were all distinguished by the tenacity of their memories; as, indeed, he soon found to his cost, for they were sure to leave him far behind in every competition, where the exercise of this faculty was essential to success. This observation gave rise to others; it suggested the notion, that other intellectual endowments might also be indicated by the features; and Gall, by degrees, came to imagine that he had discovered a number of external signs, which respectively indicated a decided turn for painting, for music, for mechanical arts, or other objects. He had by this time commenced the study of medicine; and, in the course of his academical instructions, he heard much about the functions of the muscles and viscera; but nothing was taught about those of the brain and its different parts. It then occurred to him, that the differences he had already noticed in the external configuration of the head, as connected with certain dispositions of mind, were occasioned by differences in the form of the brain. Delighted with the prospect which this idea opened to him of discovering the functions of particular parts of this organ, and of obtaining an insight into the connexion between the mind and the body, he formed the resolution of prosecuting the research, till he had either accomplished his object, or satisfied himself that it was not to be attained by that method. Natural history, which had long been his favourite study, furnished ample scope for the extension of these inquiries. He had been in the practice of collecting plants and animals of various kinds, and of arranging them, not according to the artificial methods of classification detailed in books of science, but according to their more obvious resemblances. He now studied the relations between their external forms, and their natural habits and dispositions. Dogs showed him the greatest diversities in their capabilities of being educated. He remarked that some were naturally expert at the chace, while others, of the same breed, could not be trained without the utmost difficulty; that some perpetually lost themselves, while others found their way home from great distances. In birds, he observed that one would listen with attention to a tune which it heard, and immediately learn it; while another of the very same brood would sing nothing but the note that was natural to it. Whence, he would ask himself, can arise this wide diversity among individuals?

The solution of this difficult question was not to be hoped for, unless by means of observations conducted on the largest possible scale. He therefore set about examining all the skulls he could lay hold of, that had belonged to individuals whose history was known. He looked out for all persons in any way distinguished for a particular talent or moral quality. He examined their heads with great attention, and noted the peculiarities in their shape. He also collected observations on other individuals, who were remarkable for the weakness of any faculty, and then compared together the positive and negative indications. On the other hand, when he chanced to meet with a head that presented some singularity in shape, he was at much pains to obtain information as to the moral and intellectual character of the person to whom it belonged. When he had no other resource, he did not scruple, as Dr. Spurzheim informs us, to address his questions directly to the person in whose head he observed any distinct protuberance. We are also told, that he was in the habit of collecting around him the boys he met with in the streets of Vienna, and of inducing them, by petty bribes, to confess their own faults, and betray those of their companions. He excited them, for instance, to fight together, in order to discover which possessed most courage, and thence drew inferences as to the organ which prompted that sentiment. In order to obtain more precise data for his conclusions, he endeavoured to procure models of the more remarkable heads that he met with, and generally got permission from the individuals themselves to take a cast of their heads in plaster of Paris. The Count of Sauran, then minister of police at Vienna, gave him material assistance in effecting these objects; and he was thus in no long time in possession of a very large collection of casts, all bearing more or less upon the several points of his theory. If he happened to hear of the death of any one whose head he had already moulded, he was at great pains to procure his skull, that he might compare the form of its different parts with the shape of the head during life. As it was soon known that the doctor aimed chiefly at those who possessed some remarkable talent, a very general alarm spread itself amongst the inhabitants of Vienna; and not a few were pursued with the terror of being selected as the subjects of cranioscopical investigation, and of their skulls being destined to make a figure in his anatomical cabinet. The aged Mr. Denis, librarian to the emperor, is said to have inserted an express clause in his will, to protect his head from the keen scalpel of Dr. Gall. Notwithstanding these fears and precautions, he contrived to amass an extensive collection of skulls, as well as of heads, in illustration of his doctrines. He next availed himself of the aid of comparative anatomy; and having no family to provide for, spared no expense in procuring skulls of all sorts of animals, with a view of tracing the form and size of corresponding organs throughout the whole series. Being physician to the establishment for the *deaf and dumb* at Vienna, he had opportunities of observing the natural features of uncultivated minds, and the various degrees in which they were susceptible of education. With the same view, he used to call together into his house persons of the lowest class, such as coachmen, and beggars in the street, and excite them to display their characters before him. His professional practice made him acquainted with a great number of families, and afforded him many opportunities of making valuable observations. He neglected no means of instruction that could be derived from the inspection of the heads of patients labouring under different forms of insanity. He was physician to the director of establishments for education, and was allowed to examine every child who excelled, or showed any remarkable disposition. He visited the prisons and houses of correction, as well as the hospitals for idiots and lunatics. He took casts of the heads of criminals, inquired into the offences for which they were confined, and collected the history of their lives; and thus derived from every quarter materials for bringing his theory to perfection.

His Lectures.

As his observations multiplied, he became sensible that he had fallen into many errors in the earlier periods of his inquiries, and was forced to give up many of his favourite opinions, which he found had been too hastily adopted, with regard to the general form of the head, as connected with the character of the individual. He felt the necessity of being in future more on his guard, and resolved to institute a separate examination of the different regions of the skull; and although he was here, also, frequently obliged to shift his ground in assigning the function of each part, his researches were, on the whole, attended with more uniform success. By degrees he acquired greater confidence in the stability of his conclusions, and at length ventured to announce them to the public, by the delivery of lectures on his new science. His doctrines were eagerly received, and much canvassed at Vienna; but their fame had no sooner reached the Austrian court, than a violent outcry was raised against them by the bigoted priests, who controlled all the operations of that weak and misguided government, and who represented these doctrines as tending to materialism and atheism. The consequence of this senseless clamour was, that Gall was interdicted from lecturing. But the number of those to whom he had communicated the principles of his art, and in whom he had infused a strong desire to continue to profit by his instructions, was by this time very considerable, especially among the strangers who happened to be at Vienna. They formed a strong party in his favour, and made such interest at court, principally through the medium of the foreign ambassadors, that the doctor was again permitted to resume his prelections, on condition that he delivered them to foreigners only; as it was wisely considered that their being exposed to the dangers of knowledge, would not be of any material consequence to the state, as long as care was taken that the infection did not spread farther; the emperor kindly preserving the bliss of ignorance for the exclusive enjoyment of his Austrian subjects.

Publications and travels.

It was long before Gall committed himself by writing on the subject that had procured him so much celebrity. He merely announced, in 1798, in a letter addressed to Baron Retzer, which appeared in the *Deutsche Merkur* of Wieland, his design of publishing a large work on the new theory, of which he affords his readers only an imperfect glimpse. A detailed account was afterwards given by M. Froreiss, one of his pupils, in the second volume of Voight's *Magazin Physique;* and an amusing outline appeared from the pen of M. Charles Villers, in a letter addressed to Cuvier. Various surreptitious copies of his lectures were also circulated throughout the protestant states of Germany, where they excited so much curiosity, that Dr. Gall was at length induced to make a tour for the purpose of delivering them himself at the principal universities in the north of Germany. With this view he visited Dresden, Berlin, Hallé, Jena, Weimar, Göttingen, Hamburgh, &c. and every where met with the most flattering reception, being invited to the several courts of the states through which he passed, and treated with the honours due to a distinguished literary character. By frequenting the first societies, and conversing with the best informed persons, he had ample opportunities of extending his observations, and he was attentive to improve these opportunities to the utmost of his power. Dr. Spurzheim, who had at an early period been associated with him in these inquiries, and who had devoted himself particularly to the anatomical researches they comprised, accompanied him in this tour, and participated in all his labours. Dr. Gall at length settled in Paris, where he continued his pursuits and lectures, and united with them the practice of his profession.

Other works on his system.

In 1810 Drs. Gall and Spurzheim published, in conjunction, the first volume, in quarto, of the work they had announced, and which was to contain a full account of their doctrines, under the title of *Anatomie et Physiologie du système nerveux en général, et du cerveau en particulier, avec des observations sur la possibilité de reconnoitre plusieurs dispositions intellectuelles et morales de l'homme et des animaux, par la configuration de leurs têtes.* The first part of the second volume appeared in 1812. This work, together with the one published in 1815, by Dr. Spurzheim, entitled *The Physiognomical System of Drs. Gall and Spurzheim, founded on an anatomical and physiological examination of the nervous system in general, and of the brain in particular, and indicating the dispositions and manifestations of the mind,* contain the most authentic account of their system. Information on the subject may, however, be derived from the following books, besides those of Froreiss and Villers, already mentioned. The best of the foreign works is that of Professor Bischoff, entitled *Darstellung der Gall' schen Gehirnund Schädellehre, nebst Bemerkungen über diese Lehre,* von D. W. Hufeland, Berlin, 1805. At Dresden, in 1806, Bloede published a similar work, viz. *Galls Lehre über die Verrichtungen des Gehirns, nach dessen zu Dresden gehaltenen Vorlesungen;* and at Paris, in the same year, we have, from the pen of Démangeon, *Physiologie intellectuelle, ou dévelopement de la doctrine du Professeur Gall.* A small tract in English, entitled *Some Account of Dr. Gall's new Theory of Physiognomy, founded upon the Anatomy and Physiology of the Brain, and the Form of the Skull,* appeared in London in 1807, and is chiefly taken from Dr. Bischoff's work, including the critical strictures of Dr. Hufeland. Soon after the publication of Dr. Spurzheim's book, a small volume, principally reprinted from a short tract in the *Pamphleteer,* was given to the public by Mr. Thomas Forster, under the title of *Sketch of the New Anatomy and Physiology of the Brain and Nervous System of Drs. Gall and Spurzheim, considered as comprehending a complete system of Zoonomy, with observations on its tendency to the improvement of education, of punishment, and of the treatment of insanity.* Two pamphlets in opposition to these doctrines were published by Professor Walter of Berlin, in 1805, of which, as well as of Bischoff's work, a short account is given in the *Edinburgh Medical and Surgical Journal* for July 1806. Dr. Spurzheim having conceived that he was unfairly attacked in some of the Reviews, thought proper to publish a reply, in a pamphlet which made its appearance at Edinburgh in 1817, entitled *Examination of the Objections made in Britain against the Doctrines of Gall and Spurzheim.* These, together with the lectures delivered in London by Dr. Spurzheim, are the sources which have supplied the materials for the following summary.

The hum faculties innate.

It is laid down both by Gall and Spurzheim as the foundation of their doctrines, that the nature of man, like that of all other created beings, is determinate, and that the faculties with which he is endowed are *innate;* that is, that they are implanted in him at his first formation, and are not the result merely of the external circumstances in which he may afterwards happen to be placed, nor of the wants and necessities to which these circumstances may have given rise. They warn us that this opinion is by no means at variance with that of Locke, who argues only against the innateness of ideas, and not of the faculties or capacities of receiving ideas. Education, doubtless, has a powerful influence in modifying and giving certain directions to these faculties; but the faculties themselves, that is, the capacities of feeling, of intellect, and of action, must have already pre-existed before they could be called into play, and thus produce the various phenomena which diversify the scene of human life. Savages have at different times been found in woods destitute of all the ordinary faculties of rational beings. Their resemblance to brutes has been supposed to be the consequence of their total want of education; but, when we come to examine into their real condition, we shall find that they are wretched beings, with great bodily defects; for the most part deeply tainted with scrofula, and almost always complete idiots. In general, they appear to have been abandoned in their childhood by their parents, to whom they were burdensome. The pretended savage of Aveyron, who was kept in the Institution for the Deaf and Dumb at Paris, was almost completely idiotical. He was quite deaf, and his head and body were incessantly in motion from side to side, even when he was sitting.

ginally erent in indi- al.

In estimating the causes of that diversity which we see prevailing in the characters and faculties of individuals, much has been ascribed to the influence of diet, mode of living, and the impressions received in early infancy, while the organs are yet tender, and highly susceptible of every kind of external influence. But the operation of these causes, as well as the power of education in general, is much too limited to explain the immense differences we observe among different men, and even among different children of the same family. Helvetius and other bold metaphysicians have maintained the paradox, that all men are born originally the same, and are moulded into what they afterwards become solely by the force of external circumstances. Genius, according to this doctrine, is a mere creature of the fancy, and originally belongs no more to one man than to another. Train all men alike, and their powers, their attainments, and their actions, will all be similar. Accident, more than design or premeditation, has fixed the destinies of great men, as well as disposed of those who are unknown to fame. "Demosthenes," say these philosophers, "became eloquent, because he heard an oration of Callistratus, whose eloquence made so deep an impression on his mind, that he aspired only to acquire this talent. Vaucanson excelled in mathematics, because, being obliged, when a child, to stay alone in the waiting room of his mother's confessor, he found there a clock, examined its wheels, and endeavoured, with the help of a bad knife, to make a similar machine of wood. He succeeded; and one step leading on to another, he arrived at the construction of his wonderful automatons. Milton would not have composed his *Paradise Lost*, had he not been deprived of his place of secretary to Cromwell. Shakspeare composed his tragedies because he was an actor, and he became an actor because he was forced to leave his native place on account of some juvenile errors. Corneille fell in love, made verses for the object of his passion, and thence became a great poet. An apple fell from a tree at the feet of Newton, while he was in a contemplative mood: this event, so trivial in itself, led him to the theory of gravitation." Reflections of a similar kind are often met with in the writings of poets and moralists. Those contained in Gray's *Elegy* must be familiar to all our readers. Dr. Johnson considered talents or genius as a thing that, when once existing, might be directed any way. Newton, he thought, might have become a Shakspeare, for, said he, a man who can run fifty miles to the south, can run fifty miles to the north.

Yet these are but the ingenious speculations of the theorist, more calculated to dazzle than to convince, and obviously in contradiction with the daily experience of mankind. Original differences in the constitution of the mind exist as certainly as in that of the body; and doubtless are dependent upon differences in organization. Children often show, from their earliest infancy, the germs of those peculiarities of character which adhere to them through life, which hardly any education can alter, and which no condition of life or variation of circumstances can afterwards affect. It is needless to expatiate on the subject of the diversities of intellectual powers exhibited by different individuals under the very same circumstances of birth and education; diversities which, as we have already seen, first directed the mind of Dr. Gall to his physiognomical researches. Many of these peculiarities are unquestionably derived from the parent, and are observed to prevail in certain families, and to descend through several successive generations.

e mental lties exer- d.

That no sensation, or other affection of the mind, and that no operation of intellect can take place without a certain condition of the nervous system, is a position established by so many direct proofs, that its truth must be generally admitted. The question becomes more difficult when we come to inquire what part of the system it is that exercises these functions. It is quite clear that the sentient principle does not reside in the nerves, or in the part which receives the first impression from the external cause of sensation. The opinion which has been embraced by many physiologists, and particularly Bichât, that while the brain is the organ of the intellectual faculties, the nerves of the great viscera of the abdomen and thorax are the seat of the moral sentiments, is at variance with a multitude of facts in comparative anatomy. There are animals endowed with the faculties ascribed to these nervous plexuses, or ganglions of the great sympathetic nerves, distributed to certain viscera, which have not the viscera in question. On the other hand, most quadrupeds have viscera analogous in their whole structure to those in man, without having the faculties of which in man it is pretended they are the seat. We have a complete series of proofs that the nerves, of themselves, and without an uninterrupted continuity with the brain, can produce neither sensation nor voluntary motion. Compression of the brain, by any cause, produces an entire suspension of all sensation and consciousness, and puts a complete stop to every operation of intellect. All the other parts of the body, on the other hand, may be wounded or destroyed, and even the nervous mass of the spinal marrow may be compressed or injured, at a certain distance from the brain, without the immediate destruction of the feelings and intellectual faculties. In tetanus, produced by a cause remote from the brain, the other nervous systems are affected in the most violent manner, while the functions of the mind continue unimpaired.

Proved by the developement of the brain;

In children, Dr. Spurzheim observes, the brain is yet pulpy, and the faculties imperfect; its growth accompanies their improvement; its maturity marks their greatest degree of vigour. If its developement has been considerable, the manifestations of these powers are energetic; if small, they are comparatively weak. In proportion as the organization of the brain decreases, the strength of the moral sentiments and intellectual faculties decreases also. If the developement of the brain take place too early or too late, the faculties exhibit corresponding variations. Certain faculties are more active in men, and others in women, according to the difference of their cerebral organization; and peculiarities of character are hereditary, according as the corresponding organization of the brain, on which they depend, is propagated from parents to their children.

by injuries and diseases;

Although many facts show that considerable injuries may be sustained by the brain without detriment to the mental faculties, yet as a general principle, it is contended by Dr. Spurzheim, that these faculties are weakened or destroyed in proportion as the brain is mechanically altered. It is, however, certain, that physiologists are by no means agreed as to this point; and that innumerable cases might be quoted in direct contradiction to this principle. These are attempted to be explained away by the general supposition, that most of them are the result of very inaccurate observations, in which the statement of the facts has been distorted and vitiated by ignorance, prejudice, or credulity; and that the rest are inconclusive as to the general question, from the observers not being aware of the real functions of the injured parts, and being inattentive to the circumstance, that almost all the parts of the brain being double, the loss of those on one side would scarcely be felt, as long as the corresponding organs on the other side remained entire. On the other hand, it should be recollected, that a derangement in an organ may occur of such a nature as that our senses cannot enable us to discover it. How often is this exemplified in fatal diseases of the nervous system, such as hydrophobia, tetanus, and atonic gout. Analogy shows us other parts where apparently no proportion is preserved between the injury and the derangement of function. Sometimes large abscesses are met with in the lungs without much disturbance of the function of respiration; and ossification of the heart, without any sensible affection of the circulation. In persons possessed of great irritability, very slight wounds of the brain may produce serious effects, while considerable wounds in others, who are less irritable, shall be attended with no bad consequences. This consideration will go a great way towards explaining the fact, that in many cases of insanity, instead of our discovering any change in the brain, a diseased state has been observed in the liver, the bowels, and other viscera; and may serve as an answer to the assertions and objections of Pinel, who states that the most accurate dissections have not taught us any thing with regard to the seat of mental alienation, and that we have no sufficient data to conclude, from diseases of the brain, that it is exclusively the organ of the intellectual faculties.

by dissections in hydrocephalus;

Those who have opposed the theory of the subserviency of the brain to the operations of mind, have laid great stress upon an argument derived from the phenomena of hydrocephalus. In patients afflicted with this disease, the brain appears to be destroyed and replaced by water; and yet the intellectual and moral faculties have remained perfect to the last. Drs. Gall and Spurzheim conceive, that the facts have been very erroneously represented; and that the only alteration which the brain sustains in these cases, is a displacement of its parts, and not an absorption of its substance. The effused fluid, by accumulating in the ventricles, gradually unfolds the convolutions of the hemispheres of the brain, and expands them to such a degree, that they are reduced to a thin stratum of substance, constituting a sort of bag, within which the fluid is still contained. This stratum of brain is sometimes not more than a line in thickness, and is generally lacerated in attempting the dissection; in which case the water rushes out, the real structure escapes notice, and the fluid is erroneously supposed to have been accumulated between the brain and its membranes.

by monsters, and by direct experiment.

It has been advanced, as another objection to the same theory, that monsters are sometimes born without any brain, who yet suck and perform various movements. Actions of this kind, however, are purely automatic, and appear to be unattended with consciousness; with such actions the brain has no concern whatever. Some have founded their opposition to the theory, on the result of some experiments of Duverney on pigeons, which, it is alleged, continued to perform all their animal functions after the whole of the brain had been removed from the skull. But Dr. Spurzheim, on repeating these experiments on birds and rabbits, found, indeed, that the destruction of the superior parts of the brain does not destroy the functions of the five senses and of voluntary motion, but that it is impossible to take out all the cerebral mass without killing the animal. As soon as the *corpora striata* and optic *thalami* are wounded, convulsions and death ensue; consequently he does not hesitate to pronounce the account given by Duverney to be entirely false. He, in like manner, wholly discredits the stories related by Morgagni, Zacutus, Lusitanus, Bartholine, Haller, Vallisneri, Moreschi, Giro, Dr. Simson, Soëmmerring, and others, concerning petrified or ossified brains being found in individuals, without prejudice to the exercise of their intellectual faculties. He admits it to be doubtful, how far, in perfect animals, the brain may be necessary to the passive consciousness of the external senses; but deems it certain, that the exertions of the will, including voluntary motion and reflection, depend entirely upon the brain; no phenomenon of this kind ever taking place without that organ.

Hypothesis of the plurality of organs.

Concluding, therefore, that the brain is the organ of the sensitive, the intellectual, and the moral faculties, we have next to inquire, whether these faculties are exercised in common by the whole, or any particular portion of the brain, or whether, on the other hand, they are more especially the offices of different parts of that organ. Dr. Gall adopts the latter of these opinions, and upon this view of the subject is the whole of his system founded. The following is the reasoning on which he builds it.

Arguments in its favour derived from there being no assignable censorium commune;

Physiologists, influenced by the metaphysical tenets of the schools, have often maintained, that the soul, being simple, its material residence must be simple also, and that all the nerves must end in one point; or, which amounts to the same, that they can have but one common origin, because each individual has but one soul. Bonnet, Haller, and others, who had extended its seat to the whole substance of the brain, were opposed by these metaphysicians, who did not reflect that a little more or less room could not enable them to explain any better the nature of the soul; nor that, as Van Swieten and Tiedemann remark, a material point, in which all ideas and sensations should centre, is inconceivable, in consequence of the confusion and disorder that would result from such an arrangement. It appears ridiculous, indeed, that the physiologist, to whom all nature is open, should direct his researches and inductions by the guidance of such frivolous speculations. Great pains were, however, taken to determine this central point, or *sensorium commune;* but it is enough to enumerate the various and contradictory opinions that have been held with regard to it, in order to be satisfied of the utter futility of this research. Descartes, in his treatise on the *Passions*, labours to prove that the soul is concentrated in the pineal gland. This hypothesis continued in fashion for some time, till it found an enemy in a follower of Descartes, the Dutch physician Boutekoe, who dislodged the soul from its narrow watch-tower in the pineal gland, and confined it in the more spacious prison of the *corpus callosum.* Lancisi, Maria, and La Peyronie, successively declared themselves in favour of this new opinion; and the latter of these anatomists wrote a memoir in support of it, which was printed by the Academy of Sciences in 1741, and which has since been republished separately. Digby next transferred the soul to the *septum lucidum* in place of the *corpus callosum.* Vieussens allowed it greater latitude, assigning for its boundaries those of the *centrum ovale* of the medullary substance. Willis, again, restricted it to the *corpora striata;* Serveto, to the aqueduct of Sylvius. Wharton and Schellhammer placed it in the commencement of the spinal marrow; Molinetti and Wrisberg in the *pons Varolii;* Crusius and Meig in the origin of the *medulla oblongata;* whilst Drelincourt and others lodged it altogether in the cerebellum. Lastly, Soëmmerring imagined the soul to reside in the serosity which moistens the inner surface of the ventricles, to which he had traced the extremities of many nerves from the organs of sense; and conceives that the different motions or oscillations of this fluid are the immediate material cause of our sensations.

from various analogies;

Discarding the notion that the functions of sense and intellect are concentrated in any particular point or portion of the brain, let us next examine the opinion that all the faculties are exercised by the whole mass of brain considered as one organ. We may, in the first place, remark, that the analogy of other parts of the system is adverse to this hypothesis. Every different secretion has its appropriate gland, the offices of which are never interchanged. The liver never secrets urine, nor the kidneys bile. The five external senses are distinct and independent of one another. Every where do we observe that nature, in order to produce various effects, has varied the material organs. The structure of the brain in its different parts, is far from being simple and uniform; it is composed of two substances; the one soft, pulpy, and ash-coloured; the other white, opaque, and fibrous in its texture. The fibres of the latter run parallel to each other, having, at the same time, various collateral connexions, but by no means uniting in any one central part which can be considered as their common origin or termination. The parts of the brain are numerous, and distinct from one another, bearing evidence of a very complex and artificial construction. They are constant in their general arrangement in different subjects, shewing in this respect a striking contrast with the distribution of blood-vessels, or even the disposition of the muscles and viscera, in which it is so common to meet with variations. Comparative, as well as human anatomy, furnishes strong analogical arguments in favour of a plurality of the cerebral organs, corresponding to the plurality of faculties. However defective may be our knowledge of the structure of these organs in the lower animals, still a general comparison of their faculties, as we ascend in the scale of being, shows us that the number of these faculties increases in proportion as the cerebral parts are multiplied. The immense augmentation of the powers of intellect which we behold in man, when compared with the limited instincts of animals, is neither in proportion to the increased size of the five external senses, nor of any other part of the body, but to the increase of the cerebral organs only. It is the great size of the hemispheres of the brain, more especially, that characterizes this organ in man, and establishes its superiority, as an instrument of intellect, over that of all other animals. Man unites in himself all the organs which are variously scattered and distributed among the brute creation; but he has also organs in his brain, which no other animal besides himself possesses; and these are the seats of faculties of a higher order, peculiar to him alone.

f n the d rsity of c acters a ngst n.

Considerations arising from the differences in the proportional energy with which the faculties manifest themselves in different individuals, are also in favour of the plurality and independence of the organs. If the brain were one simple organ of mind, and alike instrumental in all its faculties and operations, wherever we met with any one faculty in a state of high energy, we must suppose the whole organ adapted to produce this degree of energy, and ought to expect its other operations to be equally energetic. Yet we may find the same individual remarkably deficient in other faculties, which are equally dependent on this organ. One person shall excel in verbal memory, while he cannot combine two ideas philosophically; another is a great painter, but a bad musician, or a wretched poet; another is a good poet, but a bad general. If the brain be a single instrument, it cannot be at once both weak and strong; it cannot exhibit one faculty in its perfection, and another in a very limited extent. But all difficulty vanishes if we admit it to be an assemblage of many organs; for the combinations of these organs may be as infinitely diversified as the actions and powers of man. The argument derives additional force from the readiness with which this theory may be applied to explain the diversity of character we meet with in the brute creation, and especially to the varieties of disposition observable among some of our domestic animals, which, under the same circumstances of education, exhibit such different qualities. In like manner, the diversity of character in the same individual, at different periods of his life, are most readily explicable on the supposition of distinct organs, which have their respective periods of growth, maturity, and decline. The analogy of the external senses is also strongly in favour of the same doctrine. Thus the taste and smell appear earlier than the senses of seeing and hearing, because their respective organs are earlier developed. This reasoning will be confirmed when it is found, as will afterwards be shown, that the proportional size of the different parts of the brain is very different in different individuals. Is it not, therefore, reasonable to suppose, that the different energies of the several functions of the mind are connected with these differences in the structure of the organs which respectively produce them?

fro na- logy

The faculties of animal life are incapable of long continued exertion; rest is necessary for the renovation of their powers. Fatigue is the consequence of the prolonged action of the muscles of voluntary motion; but when one set of muscles are fatigued, the power of others is still unimpaired, and they are ready to be employed in a different action, without any additional fatigue. When we have been long sitting, we are relieved by standing; and even the bed-ridden find ease from a change of posture. Our eyes, in like manner, may be fatigued by looking at pictures; but we can then listen to music, because there is one organ for seeing, and another for hearing. It is well known that study, long protracted, produces fatigue; but we can continue to study, provided we change the object of attention. If the brain were a single organ, the whole of which is employed in performing all the functions of mind, a new form of study should increase instead of relieving the sense of fatigue. Thus the analogy is complete between the phenomena of mental and bodily exertion. Are we not, then, justified in extending it to the instruments by which these operations of mind and body are effected?

from the phenomena of sleep, dreaming, and somnambulism:

The phenomena of sleep are also readily accounted for on this hypothesis. During this state all the organs do not remain inactive; but sometimes a particular organ enters into action, and this constitutes dreaming. The state of vigilance is that in which the will can put in action the organs of intellectual faculties, of the five senses, and of voluntary motion; but it is incorrect to define it as the state in which all these organs are active, for it is impossible that all the faculties should be active at the same moment. Somnambulism may be regarded as a state of still more incomplete sleep, or one in which several organs are watching. If, during sleep, the action of the brain is partial and is propagated to the muscles, locomotion takes place; if to the vocal organs, the sleeping person speaks. All this may take place in different degrees. Some persons dream and speak in their sleep; others dream, speak, hear, and answer; others, besides dreaming, rise, walk, and do various things. This latter state is called somnambulism; that is, the state of walking during sleep. Now as the ear can hear, so the eyes may see, while the other organs sleep; and there are undoubted facts which prove that several persons in the state of somnambulism have seen; but it has always been with the eyes open. There are also convulsive fits in which the patients see without hearing, or *vice versa*. Some somnambulists do things of which they are not capable in a state of watching; and dreaming persons reason sometimes better than they do when awake. This phenomenon is not astonishing. If we wish to reflect upon any subject, we avoid noise, and all external impressions; we cover the eyes with our hands, and we put to rest a great number of organs, in order to concentrate all vital power in one, or in a few. In the state of dreaming and somnambulism this naturally happens; consequently the manifestations of the active organs are then more perfect and more energetic; the sensations are more lively, and the reflections deeper than in a state of watching.

from states of disease;

States of disease are also adduced as proving the plurality of the cerebral organs. In many cases of insanity we find only one faculty deranged, whilst all the rest are in a perfectly sound state. Lunatics, on the other hand, are met with, who are reasonable only while pursuing some particular train of thought. There was a chemist, for instance, who was insane on every subject except chemistry. An embroiderer, during her paroxyms of insanity, while uttering the greatest absurdities, calculated correctly how much stuff was necessary to such or such a piece of work. The effects of blows, or other injuries on the head, supply facts of a similar kind, which afford still more convincing proofs that the brain is susceptible of being very partially affected. Some persons lose from this cause the memory of proper names, while they preserve the memory of words which indicate the qualities of objects. One Lereard of Marseilles, after having received a blow from a foil in the orbit, lost entirely the memory of names; sometimes he did not recollect those of his intimate friends, or even of his father. Cuvier, in his historical eulogium on Broussonet, states that this celebrated botanist, after having recoverd from an apoplectic fit, never could recollect proper names nor substantives, though he had recovered his prodigious memory with respect to other objects. He knew plants, their figure, leaves, and colours; he recollected the adjectives, but could never recover the generic substantives by which they were designated. These and similar instances of partial affections of the faculties support the supposition of their being owing to different conditions of various parts of the brain subservient to these faculties.

and from authorities.

Lastly, the doctrine that different portions of the brain exercise different mental functions, is countenanced by numerous authorities in former as well as in modern times. It is expressly stated in the writings of Boerhaave, Van Swieten, Haller, Prochaska, Soëmmerring, &c.; and the Academy of Dijon long ago proposed it as a prize-question, to determine the situation of these different cerebral organs. Charles Bonnet, indeed, went the length of maintaining that each fibre of the brain is a particular organ of the soul.

Charge of materialism unfounded.

It seems hardly necessary to expose the absurdity of the accusation that these doctrines tend particularly to materialism, although the dread of such a consequence has been sanctioned by royal edicts. There are two opinions only, which, in respect to this question, stand opposed to each other; namely, that which asserts perception to take place by the intervention of a material organ, and that which asserts it to take place immediately by the energies of the mind itself, or at least without the intervention of the body. The doctrines of Gall are unquestionably incompatible with this last opinion, that is, with pure immaterialism, which may in fact be regarded as denying the existence of matter altogether. This sceptical spiritualism can be avoided only by the admission of the necessity of a material organ; and if this be admitted, any modification of such opinion, that does not exclude mind as the ultimate percipient, must be equally remote from absolute materialism. The immaterialist believes that it is the soul which sees and the soul which hears, as much as that it is the soul which judges and the soul which imagines; and since he does not condemn, as impious, the allotment of different organs of sight and hearing, what greater heresy is there in the allotment of different parts of the sensorium, as the organs of judgment and imagination? If, indeed, any one were to say, that the affections of these parts are themselves judgment and imagination, he would be a materialist; but he would be as much a materialist, if he should say, that the affections of the organs of sight and hearing are themselves the ideas of colour and sound.

Determination of the functions of the cerebral organs, by their relative size.

Supposing it, then, established that each function of the mind is exercised by a separate portion of the brain, let us next inquire whether observation can furnish us with any means of determining the precise nature of the function, to which each particular organ is subservient. Although it is clear that the adaptation of each organ to the performance of its office, must be wholly dependent on its particular organization, yet it is equally evident that no consideration of its general structure as shewn to us by anatomy, can teach us *a priori* what such function really is, and still less what may be its degree of energy, or its peculiar quality and modifications. The energy of the function must in all cases depend on certain conditions of the organ, such as the perfection of its original constitution, its elaborate texture, its relative size, and the degree of exercise it has received; and will also be regulated by the influence which other faculties may exert on its operations. The only one among these conditions, which is open to observation, is the relative size of the organ. In general, we find that the properties of bodies act with an energy proportionate to their size. A large loadstone attracts a greater mass of iron than a small loadstone. A large muscle, in like manner, is stronger than a small one. If the nerves of the external senses be larger on one side of the body, the functions on that side are also stronger. Comparative physiology shews us that the olfactory, optic, and auditory nerves of those animals which are distinguished for the excellence of their smell, sight, or hearing, are marked by being numerous and large, evincing a more elaborate developement. The coincidence is so uniform as to justify the general inference, that wherever any organ is met with in a higher state of developement, we may there expect to find the power dependent on it increased in energy in the same proportion. May not this analogy be fairly extended to the organs which compose the brain? Our present object, it must be recollected, is not to determine every degree of activity existing in a cerebral part, but merely the *nature* of its function; and for this purpose the indication afforded by its comparative size, in different cases, will suffice.

Process fo conducting the inquiry

We may observe in different individuals a considerable variation in the proportional developement of different parts of the brain. It is reasonable to suppose, that the functions which are more developed in one person than in others, will be more active, and manifest themselves with more energy, than those which are less developed. Those which are comparatively small we may expect to be less active, and their powers more feebly exerted. Let us then select as the subjects of observation such persons as are marked by strong peculiarities of mind or character, and especially such as are endowed with a partial genius, as it is called; that is, who manifest in a very high degree any particular faculty of mind: let us note the peculiarities in the form of their heads, and observe what organs in them are of an unusually large size. By repeated comparisons we shall arrive at the knowledge of the particular organ in which that faculty resides. The converse method, on the other hand, must be pursued with those who betray a singular deficiency of power in any faculty. With such persons we must endeavour to discover what particular part of the brain exhibits an imperfect developement. The results of both these modes of determining the functions of each organ, when compared together, will correct, and, if just, will ultimately corroborate each other. Experience, multiplied and extended, will finally confirm and establish our conclusions, and complete the system in all its parts.

Correspodence in shape between the skull and brain.

But the living brain can never be exposed to observation, and, from the nature of its substance, loses much of its form and texture soon after death. It may appear impossible to discover the form or size of particular parts of the brain during life, since the whole mass is inclosed in the bony case of the skull, of which the thickness varies in different parts; and since the skull itself cannot be immediately inspected, being covered by muscles and integuments, which, by contributing to smooth all the inequalities of its surface, must preclude us from forming an exact estimate of its real shape. This obvious objection to the proposed inquiry, Drs. Gall and Spurzheim labour to remove by the following considerations. If we attend to the successive stages of the growth of the skull, we find that its ossification begins at different points; and the bony processes extend in divergent lines, adapting themselves exactly to the form and size of the cerebral parts they are destined to inclose and protect. Whatever violence may be done to the bones of the skull during birth, they soon return to their natural state, partly from their elasticity, and partly from the inherent powers of the brain, which tend constantly to restore its original shape. The compression of the brain is besides of too transient a nature to produce any permanent change in the primitive forms either of the skull or of the brain. If it ever amounted to what could irrecoverably derange the organization, and hinder its future developement, the necessary consequence of such a degree of violence would be death or idiocy.

In the progress of its growth, the increasing dimensions of the skull keep pace with those of the brain. All the cerebral parts do not increase simultaneously; and this partial developement is equally observable in the skull. The forehead, for instance, which at birth is narrow and flat, grows wider and more prominent from the age of three months to that of eight or ten years. After this period, the middle part of the forehead is less developed in proportion to the other parts. The neck of the child is very small, because the cerebellum, which is situated at the inferior occipital *fossæ*, is not yet developed; but in proportion as this organ increases in size, the skull grows prominent at that part. The same happens with all the other cerebral parts which increase progressively. The shape of the skull cannot be in any degree influenced by external causes, such as occasional pressure in one direction, as happens in carrying burdens on the head, or artificial modelling of the heads of infants, as is asserted to be practised among the Caribs and other savage nations. In other parts of the body we may remark, that whatever soft parts are inclosed in bones, the shape of the latter is adapted to the dimensions of the former, and is regulated by the changes they undergo; the ribs, and even the spine, yield to the pressure of an abscess, or the enlargement of an aneurism; and the bones of the face, in like manner, make way for the increase of tumours, and adapt themselves to the new form these render necessary. By experience in feeling the living head, we may readily learn to distinguish the form of the bones which lie beneath the integuments. The observation of the shape of the skull, or of the head, is therefore capable of giving us exact information as to the relative size and shape of the different parts of the brain, and on the knowledge thus obtained is founded the art of CRANIOSCOPY.

Practical cautions.

In practising this method, however, it is necessary to guard against several sources of error. We must take into account several protuberances, which belong to the natural state of the skull, and which had some particular destinations foreign to the immediate functions of the brain; such as the mastoid processes behind the ears, the crucial spine of the occiput, the zygomatic processes, and the frontal sinuses. The cerebral parts, situated behind the orbits, indeed, require some exercise on the part of the organoscope, in order to be exactly determined. The developement may be perceived by the configuration and position of the eyes, and by the circumference of the orbits. It is therefore necessary to examine whether the eyeball is prominent or hidden in the orbit, whether it is depressed or pushed sideward, inward, or outward. According to this position of the eyeball, we may judge that such or such parts of the brain, which is situated against such or such part of the orbit, is more or less developed. The functions of those organs, which lie wholly at the basis of the brain, can be ascertained only by examination after death.

It may be objected, that the organs are not confined to the surface, or convolutions of the brain; but although this be the case, and although they really extend from the surface to the basis of the brain, or *medulla oblongata*, yet the degree in which they are expanded at the surface, where they form the convolutions, will indicate, in general, the relative magnitude of the whole organ. The analogy of the five senses, of which the peripheric expansions indicate the developement of their respective nerves, shews the reasonableness of this supposition. From a large eye, implying a large retina, or peripheric expansion of the optic nerve, we naturally infer that the nerve itself is of considerable magnitude: may we not draw the same conclusion with regard to the organs of the moral sentiments and intellectual faculties, whenever we find that the convolutions, which are their peripheric expansions, are much developed?

In feeling for the organ, Dr. Gall recommends the use, not of the fingers, but of the middle of the palm of the hand; and declares that habit, as well as a certain natural delicacy of tact, is necessary to qualify a person to make these observations with certainty of success. We are warned, also, to confine our observations to young and grown-up persons in the flower of their age; for at an advanced period of life the brain diminishing by degrees, and retiring from the skull, leads to the recession of its inner table, and consequent inequality in its thickness, which renders it impossible to judge exactly of the size or shape of brain from that of the head. Analogous changes occur in the skulls of some lunatics, and occasion similar difficulties in applying the rules of cranioscopy. It is also to be considered, that our aim is to distinguish the size, and not the mere prominence of each organ. If one organ be much developed and the neighbouring organ very little, the developed organ presents an elevation or protuberance, but if the neighbouring organs be developed in proportion, no protuberance can be perceived, and the surface is smooth.

We have already stated the mode in which Dr. Gall proceeded to apply and to verify these principles; it is now time that we should present our readers with the result of his labours.

Classification of faculties.

He arranges the faculties of the mind, with their corresponding organs, according as they relate to the feelings and to the intellect: the first class comprehending the *propensities*, all which are common to men and animals, and the *sentiments*, which constitute what the French denominate *l'ame*, and the Germans *gemüth;* and the second class comprising the faculties by which we acquire knowledge, or the *knowing faculties*, as he terms them; and also the *reflecting faculties*, which last compose what the French call *l'esprit*, the Germans *gheist*, and what we should generally understand by the term *intellect*. He finds that the organs of those faculties which men possess in common with animals, are situated towards the basis and back part of the brain; while those of the superior faculties, which are peculiar to man, are placed somewhat higher; and the organs subservient to the intellectual faculties occupy exclusively the forehead. The total number of special faculties is thirty-three, as may be seen by the following enumeration.

Organs of, 1. Amativeness.

1. Of the faculties common to men and animals, the first is that physical propensity which has for its final purpose the continuance of the species. The cerebellum, a part which occupies the lowest situation in the encephalon, is affirmed to be the organ, the actions of which give rise to this propensity. Accident led Dr. Gall to this discovery, by his noticing the size of the back of the neck in a lady whose character, in respect to this passion, was not equivocal: and subsequent observation on an extensive scale, both in the human subject and in the lower animals, have abundantly confirmed him in his opinion. The following are the leading arguments on which he has rested it. First, the great size of the organ indicates the importance of the function to which it is subservient, and there is no cause, except the existence of such an organ in the brain, that is adequate to account for this propensity. The function of copulation takes place only in those animals which have a nervous mass or cerebellum. Throughout the whole class of quadrupeds, the neck of the male is thicker than that of the female, as may be observed particularly in the bull, the ram, and the stallion. It is also remarked that vigorous pigeons are distinguished by the size of their necks.

The developement of the cerebellum is simultaneous with that of the genital organs at the period of puberty, and early castration prevents its developement, as well as that of the beard, and the organs of the voice. Wounds of the neck have been observed by Hippocrates to be sometimes followed by impotency. In other cases, however, they produce erotic excitement. Apollonius Rhodius, in speaking of the love of Medea, represents her as suffering a violent pain in the back of her neck. A case occurred to Professor Reinhold, at Leipsig, in which an excitement of the genital organs succeeded the introduction of a seton in the neck, in a boy who laboured under ophthalmia. Spirituous frictions on the neck in hysterical fits are very useful. Lastly, the position of the cerebellum is supposed to prove its destination. After hunger and thirst, no function is more necessary than that of propagating the species. This function is the most common in animals after nutrition, and the cerebellum is in the inferior part of the head. Hence it is probable, that it is destined to the propensity of propagating, or that it is, as Dr. Spurzheim expresses it, the organ of *amativeness*.

2. Philoprogenitiveness.

2. *Philoprogenitiveness*, or the love of progeny, the στοργη of the Greeks, has its seat in those convolutions of the brain situated immediately above the hind part of the tentorium, and corresponding, therefore, on the outside of the skull with the crucial spine of the occiput. Dr. Gall had observed a distinct protuberance on this part of the head in women, and comparing the skulls in his collection, found a similar elevation on the skulls of children, and on those of monkies. During five years he was in search of a faculty that was common to all the subjects of those observations, and was in the habit of suggesting this difficulty to his auditors. At length a clergyman who attended, observed that monkies have much attachment to their progeny. The Doctor pursued this idea, and found that it applied perfectly to the observed appearances, as the developement of this part coincided always with the energy of this propensity. In animals it is generally larger in the females than in the males of the same species. This rule holds good in the human subject, although it is liable to occasional exceptions; for there are men who manifest the strongest propensity to associate with children, and in whom we accordingly find this organ larger than in the generality of women. In negroes we find this organ more prominent than in Europeans. In the cuckoo, the crocodile, and other animals to whom nature has not appointed the office of rearing their progeny, this organ is extremely defective. The crime of infanticide is more likely to be perpetrated by mothers in whom this organ is deficient in size; and accordingly out of 29 women who were guilty of this crime, Dr. Gall found 25 who had this organ extremely small. On the other hand, a female, who, being seized with delirium during child-birth, imagined that she was pregnant with five children, was found to have this organ unusually large. It must, no doubt, have been of gigantic dimensions in the lady, who, stricken by the curse of the gipsey whom she had refused to relieve, was impressed with the belief that she was about to give birth to as many children as there are days in the year.

3. Inhabitiveness, or Concentrativeness.

3. The organ of *Inhabitiveness*, or the propensity which some animals, such as the chamois and the wild-goat, have to inhabit high situations, is placed still higher in the occiput than the former, in a line proceeding towards the top of the head. In animals of the same species which live in low countries, we do not meet with an equal degree of protuberance in this part of the brain, as is observable in those which prefer living in elevated and mountainous districts. This is seen even in the rat, some varieties of which choose for their dwelling corn-lofts or the higher parts of a house, while others prefer living in the cellars. This faculty is not very active in man; but Dr. Gall conceived that it was in him allied to pride and haughtiness. Dr. Spurzheim, however, disclaims this doctrine; as he thinks it impossible to confound the "instinct of physical height" with the moral sentiment of self love and pride. Mr. Combe, conceiving that this organ has a more extensive sphere of action, and that it confers the power of being conscious of every thing going on in the mind, and of concentrating the attention, terms this power *Concentrativeness*.

4. Adh
siveness.

4. The organ of *Adhesiveness*, or the propensity to attach ourselves to persons, animals, or other objects, is situated on each side of the former, immediately under the *lambdoidal suture*, and gives a fullness to the lateral and posterior part of the head. This organ is the source of friendship, moral love, society, marriage, and attachment of all kinds. Dogs have it in an eminent degree, especially those races whose fidelity and constancy are characteristic, as the terrier, spaniel, and lap-dog. It is less prominent in the butcher's dog, greyhound, and mastiff. It was very large in a notorious highwayman at Vienna, distinguished equally as a robber and a friend, and who chose rather to die than to betray his confederates.

5. Com
tivenes

5. *Combativeness*, or the propensity to fight, results from the operation of an organ, situated immediately behind the ears on each side, at a part corresponding to the posterior inferior angle of the parietal bone, and behind the mastoid process. It is the seat of anger, as well as of pugnacity; and its locality is fully established, in Dr. Gall's estimation, by an extensive series of facts. His first discovery of the seat of this faculty, was from his observation of the head ot the Austrian General Wurmser; and it was subsequently confirmed by the experiments we have already mentioned which he made on boys he had collected from the street. The breadth of the occiput is a criterion of the spirit and courage of horses, dogs, &c. The bull-dog and pug-dog are in this respect superior to the mastiff. The hyæna is strongly contrasted with the hare, and the guinea-hen with the robin red-breast.

6. Destr
tiveness.

6. *Destructiveness*, or the propensity to destroy in general, but more especially to destroy life, has its seat just above the ears; the prominence of which part will account for the strange pleasure which some people take in killing or tormenting animals, in seeing executions, and for their inclination to commit murder. Among animals, this instinct for blood is strongly marked in the carnivorous tribes, especially in the lion, tiger, and others of the feline tribe; and the breadth of their skulls in this part shows us the great size of this organ, compared with that of their victims, the sheep, the goat, or the hare. The heads of murderers have in general been found to possess a visible prominence at this place. When the band of ferocious robbers and assassins, who so long infested the left banks of the Rhine, under Schinderhanns, had been caught, and a number of them executed, Dr. Gall found this organ strikingly developed in the heads of these banditti. This propensity is frequently strong in children, in idiots, and in madmen. Its object, in the lower animals, is evidently to procure the food on which nature destined they should live; yet some animals kill more than is necessary for their nourishment. In man this propensity presents different degrees of activity, from a mere indifference to the pain of animals, to the pleasure of seeing them killed or tortured, or even the most imperious desire to kill. Dr. Gall called this faculty *murder;* but Dr. Spurzheim thinks it produces the propensity to destroy in general, without determining the object to be destroyed, or the manner of destroying it. "It gives," says he, "the propensity to pinch, scratch, bite, cut, break, pierce, devastate, demolish, ravage, burn, massacre, strangle, butcher, suffocate, drown, kill, poison, murder, and assassinate." It would seem, therefore, that this organ has a great deal to answer for.

7. Const
tivenes

7. *Constructiveness*, the propensity to build, or the disposition to the mechanical arts, is indicated by the developement of the brain at the temples. Dr. Gall found this to be the case in great mechanicians, architects, sculptors,

and designers; and also in the skulls of the beaver, marmot, field-mouse, and rabbit, which construct habitations. Hares, on the contrary, which lie in the fields, have this organ defective, although in general they resemble rabbits. He possesses the skull of a milliner of Vienna, who had a good taste, and understood perfectly the art of changing the forms of her merchandises; in this skull the organ in question is prominent. It is by means of this faculty that birds build nests, savages huts, and kings palaces. It produces also fortifications, ships, engines of war, manufactures of all kinds, furniture, clothes, toys, &c. There was a lady at Paris, who, every time she was pregnant, felt the greatest propensity to build. The excessive size of this organ may lead a man to ruin his family by building, or to coin false money.

8. *Covetiveness*, or the propensity to covet, gather, and acquire, without determining the object to be acquired, or the manner of acquiring it, has its organ situated at the temples, on the anterior inferior angle of the parietal bone. This faculty gives a desire for all that pleases; money, property, animals, servants, land, cattle, or any thing upon earth. It produces egotism and selfishness, and may, when abused, lead to usury, plagiarism, fraud, or theft. The instinct of stealing, it is asserted, is not always the effect of bad education, of poverty, idleness, or the want of religion and moral sentiment. This truth, says Dr. Spurzheim, is so generally felt, that every one winks at a little theft committed by rich persons, who in other respects conduct themselves well. Mr. Combe terms this faculty *Acquisitiveness.*

9. The organ of *Secretiveness*, or the propensity to conceal, or to be clandestine in general, is situated in the middle of the side of the head, above the organ of the propensity to destroy. Dr. Gall first observed this organ in a person who had many debts, but who had the address to conceal his real situation, so that the creditors could have no knowledge of each other. He ascribes to this faculty cunning, prudence, the *savoir faire*, the capacity of finding means necessary to succeed, hypocrisy, lies, intrigues, dissimulation, duplicity, falsehood; in poets, the talent of finding out interesting plots for romances and dramatic pieces; and finally, the quality of slyness in animals, as in the fox and the cat, who conceal their intentions, and are clever in hiding themselves.

To the second genus of the order of feelings, namely, Sentiments, belong the following faculties:—

10. *Self-love, or self-esteem.* Dr. Gall first noticed this organ, which lies in the middle of the upper posterior point of the head, in a beggar, who stated that he was reduced to his present condition by his pride, which made him neglect his business. The animals endowed with this organ are the turkey-cock, peacock, horse, &c. Dr. Gall thought this organ is the same as that of the faculty which makes certain animals dwell upon mountains; but Dr. Spurzheim, as we have already observed, draws a line of distinction between them. The two great activity of this faculty is the cause of various abuses, as pride, haughtiness, disdain, contempt, presumption, arrogance, and insolence. The want of it disposes to humility. It is said to be more active in women than in men, and that its excess is sometimes the cause of madness.

11. *Love of Approbation.* Persons fond of the good opinion of others, have the upper posterior and lateral part of the head much developed. This may be called the organ of ambition or vanity, according to the object, which may be of various kinds. A coachman endowed with this faculty is pleased if his manner of conducting horses be approved; and a general is elated if he be applauded by his nation for leading his army to victory. This faculty is more active in women than in men, and even in certain nations more than in others. More women become mad from this cause than men.

12. Organ of *Cautiousness.* Two persons at Vienna were known to be remarkable for their extreme irresolution. One day, in a public place, Dr. Gall stood behind them, and observed their heads. He found them extremely large on the upper posterior part of both sides of the head. Hence he derived the first idea of this organ. Circumspect animals also, as the stag, roe, pole-cat, otter and mole, and those which place sentinels to warn them of approaching danger, as the chamois, cranes, starlings, and bustards, have this cerebral part much developed. This faculty produces precaution, doubts, demurs; and, in general, exclaims continually "*take care.*" It considers consequences, and produces all the hesitations expressed by the word *but.* When excessive, it produces uncertainty, irresolution, unquietness, anxiety, fear, melancholy, hypochondriasis, and suicide. Dr. Gall finds this organ more strongly marked in children than in grown persons.

13. Benevolence.

13. The organ of *Benevolence* in man, or of *meekness* in animals, is situated on the superior middle part of the forehead. In most animals it is restrained to a passive goodness; but in man its sphere of activity is very considerable, producing all the social virtues, or in one word, *Christian charity.*

14. Veneration.

14. The organ of *Veneration*, or of *Theosophy*, occupies the centre of the uppermost part of the *os frontis*. Dr. Gall had observed in churches, that those who prayed with the greatest fervour were bald; and that their heads were much elevated. The pictures of saints show the very configuration which he had thus noticed in pious men; and the head of our Saviour, also, is generally represented of this shape. It is by this faculty that man adores God, or venerates saints, and persons and things deemed sacred.

15. Hope.

15. The organ of *Hope* is situated on the side of that of veneration. Dr. Spurzheim considers the sentiment of hope as proper to man, and as a sentiment necessary in almost every situation; it gives hope in the present, as well as of a future life. In religion it is called faith. Its excessive developement produces *credulity.*

16. Ideality.

16. *Ideality*, or the poetical disposition. The heads of great poets are enlarged above the temples, in an arched direction. The sentiment inspired by this organ is the opposite of circumspection; it renders us enthusiasts, while circumspection stops our career by saying "take care." If the part of the head above this organ, and a little backward from it, be very much developed, the person is disposed to have visions, to see ghosts, and to believe in astrology, magic, and sorcery.

17. Righteousness, or Conscientiousness.

17. The faculty of *Righteousness*, or *Conscientiousness*, which produces the sentiment of just and unjust, right and wrong, has its organ situated a little more forward than the organ of approbation. It produces the sentiment of duty, and constitutes what is called conscience or remorse. Dr. Spurzheim admits farther an organ of *justice*, which he seeks for on the side of the following organ.

18. Determinateness, or Firmness.

18. *Determinateness*, or *Firmness.* Dr. Gall observed that persons of a firm and constant character have the top of the brain much developed. Lavater had made the same observation. This faculty contributes to maintain the activity of the other faculties by giving constancy and perseverance. Its too great activity produces infatuation, stubbornness, obstinacy, and disobedience. Its deficiency engenders fickleness and inconstancy.

To the order called Intellect, and the first genus of that order, viz. the *knowing faculties*, belong the following species:

19. Individuality.

19. *Individuality*, or the faculty which procures us the knowledge of external beings, after we have received impressions from them by the external senses, occupies the middle of the lower part of the forehead. Dr. Gall found this part very prominent, indicating a great developement of the anterior and inferior part of the brain, in all persons, who, from their extensive, but superficial knowledge in the

arts and sciences, were capable of shining and taking a lead in conversation. It has been not unaptly, though satirically characterized as the *blue-stocking* faculty. Tame animals have the forehead more developed than wild ones, and are more or less tameable in proportion as the forehead is more or less developed; Dr. Gall, therefore, calls this organ that of *educability*. Dr. Spurzheim, however, objects to this term, and has substituted that of individuality; he also remarks that the organ is early developed in children, because they are obliged to acquire a knowledge of the external world.

20. Form. 20. The organ of *Form* leads us to take cognizance of the forms of objects, with the existence of which the preceding faculty had made us acquainted. Persons endowed with it in a high degree, have a great facility of distinguishing and recollecting persons; they are fond of seeing pictures, and if they make collections, they collect portraits. Crystallography is the result of this faculty. The conception of smoothness and roughness also belongs to it. This organ is placed in the internal angle of the orbit, and, if much developed, it pushes the eyeball toward the external angle, that is, a little outward and downward. The Chinese appear to have it in perfection.

21. Size. 21. *Size.* After the existence and figure of any body, the mind considers its dimensions or size, for there is an essential difference between the idea of size and that of form. The organ must therefore be different; it is probably however in the neighbourhood of the former.

22. Weight. 22. *Weight.* The ideas of weight and resistance, density, softness and hardness, cannot be attributed to the sense of feeling, and require, therefore, a particular faculty for their conception. Its organ must be situated in the vicinity of the two last.

23. Colour. 23. *Colour.* The faculty of conceiving colour is, in like manner, totally distinct from the sense of vision, or the faculty of perceiving light. Its organ is placed in the midst of the arch of the eye-brows, giving them, when expanded, a vaulted and rounded arch. This configuration is characteristic of painters, and is strikingly displayed in the Chinese, who are well known to be very fond of colours. This faculty is generally more active in women than in men.

24. Space, or locality. 24. *Space*, or *Locality*. The faculty of local memory, by which we recollect localities, and find our way to places where we have been before, is much stronger in some persons than in others. Animals are also endowed with it, and it enables them to return to their dwellings and their progeny, when obliged to leave them in search of food. It is conspicuous in some dogs; while others are very deficient in this respect. The migration of birds is the result of this faculty. The pictures and busts of great astronomers, navigators, and geographers, as of Newton, Cook, Columbus, &c. present a great developement of this organ, which is situated under, but extends a little beyond, the frontal sinuses. The swallow, the stork, and the carrier-pigeon, have all this organ. This faculty conceives the places occupied by the external bodies, and makes space not only known to us, but inspires a fondness for this kind of knowledge. It makes the traveller, geographer, and landscape painter; it recollects localities, judges of symmetry, measures space and distance, and gives notions of perspective.

25. Order. 25. *Order.* This faculty enables us to conceive order. It gives method and order in arranging objects as they are physically related. Its organ is probably situated outward, but not far from the organs of size and space.

26. Time. 26. *Time.* Ideas of time are the result of a distinct faculty; for they may exist without those of order and number. They seem to be higher in the scale, and their organ, accordingly, occupies a higher place in the brain.

27. Number. 27. *Number.* All the ideas that are concerned about unity or plurality, that is, about number, belong to a faculty whose organ is situated in a part of the brain near the external angle of the orbit. The object of this faculty is calculation in general. When much developed, the arch of the eye-brows is considerably depressed, or is elevated at the outer extremity. This conformation is apparent in the portraits and busts of great calculators, as Newton, Euler, Kaestner, Jedediah Buxton, and Pitt. The heads of negroes are very narrow at this part; and, in general, they do not excel in this faculty.

28. Tu 28. *Tune.* The perception of musical tone is distinct from that of sound, and implies a different faculty from that of hearing. Its organ is placed on the lateral parts of the forehead. Its form varies according to the direction and form of its convolutions. In Gluck and Hadyn, it has a pyramidal form; in Mozart, Viotti, Zumsteg, Dusseck, and Crescentini, the external corners of the forehead are enlarged but rounded.

The heads and skulls of singing birds, especially the males, exhibit this organ fully developed. Monkeys are absolutely destitute of it.

29. Lan guage. 29. *Language.* The organ of the faculty of learning the artificial signs for the operations of the mind, of perceiving their connection with the thing signified, and of remembering them, and judging of their relations, occupies a transverse situation in the midst of the knowing faculties, and presses upon the basis of the orbit of the eye, so as to project the eye forwards when much developed. This produces what is commonly called a goggle-eye, denoting strong verbal memory. Sometimes the eyes are not only prominent, but also depressed downward, so that the under eyelid presents a sort of roll, or appears swollen. Such persons are fond of philology, that is, they like to study the spirit of different languages.

The second genus of the order Intellect, viz. the reflecting faculties, contains the following species:—

30. Co parison. 30. *Comparison.* This faculty compares the sensations and ideas of all the other faculties; and points out their difference, analogy, similitude, or identity. Dr. Gall observed various persons, who, in every conversation, had recourse to examples, similitudes, and analogies, in order to convince others; and seldom to reasoning and philosophical arguments. In them he found, in the midst of the superior part of the forehead, an elevation which presented the form of a reversed pyramid, and he named this organ, according to its functions, the organ of analogy. Nations who have this faculty in a high degree are fond of figurative language.

31. Ca lity. 31. *Causality.* This faculty examines causes, considers the relations between cause and effect, and always prompts men to ask, *Why?* Persons fond of metaphysics have the superior part of the forehead much developed and prominent in a hemispherical form, as Mendelsohn, Kant, Fichte, and others. The ancient artists have given to Jupiter Capitolinus a forehead more prominent than to any other antique head.

32. W 32. *Wit.* Persons who have this faculty, who write like Sterne, Voltaire, Piron, &c. have the superior external parts of the forehead elevated. The essence of this faculty consists in its peculiar manner of comparing, which always excites gaiety and laughter. Jest, raillery, mockery, ridicule, irony, &c. are its offsprings.

33. In tion. 33. *Imitation.* Persons who have a considerable elevation of a semi-globular form at the superior part of the forehead, have the faculty of imitating, with great precision, the gestures, voice, manners, and, in general, all the natural manifestations of men and animals. They have a disposition to be actors, and are prone to gesticulation. This organ is, in general, more developed in children than in adult persons.

To the above catalogue of the organs enumerated by Dr. Spurzheim, Mr. Combe has since added the two following, namely, 3 Won- de

34. The organ of *Wonder*, (situated immediately above *Ideality*, in the lateral parts of the anterior regions of the vertex,) which occasions the belief in the reality of ghosts, and other mysterious apparitions and visitations, and inspires a love for all that is marvellous and supernatural, and also a taste for novelty and fashion. When largely developed, it excites young men, born and bred in inland situations, to choose the sea as a profession.[1]

35 ventu- al

35. The organ of *Eventuality*, which, when large, gives prominence or a rounded fulness to the middle of the forehead. "The function of this faculty is to take cognizance of changes, events, or active phenomena, indicated by active verbs. In such expressions as the ROCK *falls*, the HORSE *gallops*, the BATTLE is *fought*, the substantive springs from Individuality, and the verb from Eventuality. It prompts to investigation by experiment, while Individuality leads to observation of existing things. Individuality gives the tendency to personify abstract ideas, such as Ignorance and Wisdom; and Eventuality to represent them as acting. An author in whom Individuality is large, and Eventuality small, will narrate actions, but deal little in physical description."[2]

Two other primary faculties are mentioned by Mr. Combe; one, which he terms *Alimentiveness*, or the desire of eating and drinking; and another, which had been called by Spurzheim *Vitativeness*, or the *Love of Life*; but the seat of these powers has not been exactly determined.

A lica- tic of the dc ine.

Excepting in the case of idiots, all the thirty-five organs above described are possessed by every person, but they exist in greater or less perfection in different individuals. Peculiarity of character is the result of irregularity in the original structure, or inequality in the relative developement of the several organs; circumstances which, according as they are diversified, lay the foundation of every excellence, as well as constitute the fatal sources of vice and depravity. These doctrines should, however, by no means be understood as lending their sanction to the latter; for crimes are considered as flowing from the abuse of certain faculties, and as still requiring for their prevention the counteracting influence of morality, and the salutary coercion of law. It must be of importance to every individual to know, if such knowledge be attainable, what is the degree of energy of the propensities and other faculties with which he may have been naturally and originally endowed; because every organ and corresponding faculty may be invigorated by proper exercise. The business of education will accordingly consist in exciting or restraining their developement, according to their natural deficiency or exuberance. Phrenology, by pointing out what are the strongest faculties in a child, will enable us to adopt the best plan of intellectual, as well as moral discipline; will assist us in regulating his passions, and maintaining a due balance between all his moral sentiments; and guide us in the choice of a profession for our pupil, conformable to the particular bent of his genius. "What benefit would arise to society," says Mr. Forster, the zealous advocate of these doctrines, "should we be enabled to make a just election of objects in youth, to be placed in situations capable of ripening their naturally energetic faculties. Phrenology will lead to important considerations regarding criminal punishment, particularly in houses of correction. It will enable us to distinguish, not only between those who have naturally strong evil propensities, from those whom distress or other contingencies may have hurried on to crime, but will point out the particular nature of the evil propensities to be corrected." It will also tend, he conceives, to establish important distinctions between different kinds of insanity, and enable us to discover the treatment appropriate for the cure of each. Lastly, it may prepare the way to a radical improvement of the human race, by pointing out those conformations of the head which it is desirable to eradicate or to perpetuate, and which should therefore be avoided or preferred in the choice of marriages. "It is certainly a pity," says Dr. Spurzheim, "that, in this respect, we take more care of the races of our sheep, pigs, dogs, and horses, than of our own offspring."

Objections to this system.

Such is the body of doctrines, and such the reasonings in their support, which have emanated from the school of Gall and Spurzheim, and which they have dignified with the appellation of a new science. A host of opponents, as might be expected, have arisen against a system so much at variance with common notions, leading to conclusions so remote from vulgar apprehension, and admitting so easily of being held up to ridicule by partial or exaggerated statements. We have already noticed the objection founded upon its supposed tendency to favour materialism, and shall pass over others of a similar nature, which proceed upon the presumption of a greater knowledge of the laws of the creation than we really possess, or which are derived from imperfect or mistaken views of the theory itself. We shall also refrain from employing the weapons of ridicule against a system so vulnerable to its attacks, and which would have been so capable of affording Swift a new incident for the history of the philosophers of Laputa. The simple exposition of the sandy foundation on which it has been built, of the flimsy materials of which it has been composed, and the loose mode in which they have been put together, will suffice to enable our readers to form their own conclusions as to the soundness and solidity of the edifice.

No particular part of the brain necessary.

It is, in the first place, obvious, that nothing like direct proof has been given that the presence of any particular part of the brain is essentially necessary to the carrying on of the operations of the mind. The truth is, that there is not a single part of the encephalon, which has not, in one case or other, been impaired, destroyed, or found defective, without any apparent change in the sensitive, intellectual, or moral faculties. Haller has given us a copious collection of cases, which bear upon this point; and a similar catalogue has been made by Dr. Ferriar, who, in a paper in the fourth volume of the *Manchester Transactions*, has selected many of Haller's cases, with considerable additions from other authors. The evidence afforded from this mass of facts, taken conjointly, appears to us to be sufficient to overturn their fundamental proposition. This evidence is not impeached by the feeble attempts of Dr. Spurzheim to evade its force, by a general and vague imputation of inaccuracy against the observers, or by having recourse to the principle of the duplicity of each of the cerebral organs; a principle of very dubious application, on a subject of so much uncertainty as the physiology of the brain. Poor, indeed, must be his resources, when we find him resorting to the following argument, in proof that the brain is the organ of thought, namely, that "every one feels that he thinks by means of his brain." We doubt much if any one has naturally that feeling.

Analogical arguments combated.

It requires, also, but a slight attention to perceive, that the very ground-work on which the whole of the subsequent reasoning proceeds, namely, that the different faculties of the mind are exercised respectively by different portions of the brain, is in no respect whatever established. The only arguments in its favour which bear the least plausibility, are derived from analogy. Now, analogy, in reasoning concerning the unknown operations of nature, is, at best, but slippery ground; and when unsupported by any other kind of evidence, cannot lead to certain knowledge, far less constitute the basis of an extensive system. The utility of analogical deductions as to what takes place in one department of nature, from our knowledge of what occurs in another, consists chiefly in their affording indications of what may possibly happen, and thus directing and stimulating our inquiries to the discovery of truth by the legitimate road of observation and experiment. But to assume the existence of any such analogy as equivalent to a positive proof, resulting from the evidence of direct observation, is a gross violation of logic. Yet it is upon assumptions of this kind that Drs. Gall and Spurzheim have ventured to found all the leading propositions of their doctrine. In the secretions of the body, they observe, the preparation of different fluids is consigned to different glands, having different appropriate structures; and they consider this analogy as a demonstrative proof of what happens in the operations of thought, and the phenomena of the passions, which, because they differ as much in their nature as milk does from gall, must, accordingly, be the result of actions in different portions of the brain; which portions are, therefore, to be regarded as so many different organs, rather than as parts of one organ. Even in a case where all the analogies are favourable to one side of a question, such a loose mode of reasoning would be entitled to little confidence; but how fallacious must it not prove, when analogies can be pointed out which apply in the opposite direction? It requires no extensive knowledge of the animal economy to perceive, that modifications of functions equally diversified with those of the intellect, are, in many cases, the result of actions taking place in the same organ. Does not the same stomach digest very different and even opposite kinds of aliment? Yet we do not find that one portion of that organ is destined for the digestion of meat, and another for the digestion of vegetable matter; although the operations required for the conversion of such different ingredients into the same chyle, cannot possibly be the same. Nerves perform the double office of volition and sensation; but the different bundles of fibres which convey each impression, the one to the muscles, the other to the sensorium, are wrapped up in the same sheath, and are so intimately intermixed during their course as to constitute a single cord. The same organ serves for the hearing of acute and of grave sounds. The whole retina, and not merely different portions of its surface, receives the impression of different kinds of colour; there is not one organ for the perception of blue and another for the perception of red rays. Guided by such analogies as these, might we not be equally justified in concluding, that the same part of the brain may serve for the memory of words, as for the memory of things; and that the same portion of that organ which enables us to conceive the idea of figure, may also suggest to us that of size?

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[1] *System of Phrenology*, fourth edition, p. 381.

[2] *Ibid.* p. 518.

The same doctrine of the plurality of cerebral organs, is endeavoured to be supported by another analogy, equally vague and loose with the former, namely, that the sense of fatigue from long continued muscular exertion, resembles, in its circumstances, the effects of long continued study on the mind, and is equally relieved, in both cases, by a change of action. To us, however, it appears, that this analogy might, with equal justice, have been adduced, as favouring the opposite view of the subject; for we can just as readily conceive the sense of fatigue to take place from the exercise of the whole organ in a particular mode, as from that of any part of the organ; and relief must equally, in both cases, be experienced from the ceasing of that action, or from the substitution of one of a different kind. The muscles admit only of one kind of action; and the energy which each derives from the nerves, when once exhausted, is not so readily replaced from the general stock belonging to the system. In the finer textures of the body, which approach more to that of the brain, the analogy not only fails of giving support to the doctrine, but has an opposite tendency. The same retina, when fatigued by the continued impression of a particular colour, is still as ready as before to receive the impression of another colour. The circumstance of partial fatigue with regard to one set of actions, may, therefore, exist, without implying the necessity of a separate organ for the performance of these actions. Indeed, if the brain have any laws similar to those of muscular motion, it must have a much greater number peculiar to itself, and all such distant analogies as those we have been considering, must be perfectly inconclusive. Similar observations will apply to the explanation of the phenomena of sleep, of dreams, of somnambulism, of partial losses of memory, and of insanity. It is equally conceivable, that they should result from the imperfect or differently modified actions of one organ, as from the separate activity of different parts of that organ, whilst the other parts are inactive. Analogies may be equally adduced in support of both sides of the question, and can certainly prove nothing on either.

Futility of anatomical proofs.

Drs. Gall and Spurzheim appeal with great confidence to anatomy, and particularly to their own anatomical discoveries, as affording a solid support to their doctrines. "We never," say they, "separate anatomy from physiology, for physiology without anatomy is unfounded; while anatomy without physiology is useless. A physiological system of the brain would necessarily be false, were it in contradiction with its anatomical structure." This conclusion, which at best is but a negative one, is totally inapplicable to the theories in question. The anatomy of the brain is so complex, and so void of apparent adaptation to any purpose we can understand, that it will suit any physiological system nearly equally well; at least it can never be adduced in contradiction of any hypothesis, however wild, that can be framed as to the mutual operation of soul and body. All that these anatomists have done, in this respect, is to show that there is no appearance of a common centre of departure or of a collection of nervous filaments. The separation of the parts of the brain and their diversity of shape, can no more be evidence of a diversity in their functions, than the multitude of distinct and separate lobules which compose the kidneys of birds, and of a great number of quadrupeds, are indications that each part performs a different office. Comparative anatomy, indeed upon which so much is made to hinge, is of all guides the most fallible in questions of this nature; since we behold, in numberless instances, a great variety of ways in which nature accomplishes the same function and the same purpose, in different departments of the animal creation. But on a comparison of animals with each other, it may even be doubted, whether there is any connexion or proportion observable between their intellect or inclinations and the number of parts in their brains.

The possibility of discovering the size and the shape of the different parts of the brain from the external examination of the head, is also discountenanced by anatomy. There are often considerable impressions on the interior of the skull, where the corresponding exterior surface does not exhibit the slightest appearance of projection, and is sometimes even depressed; and there are frequently large prominences without, where there are no corresponding concavities within; so that when the outer surface of the bony case is compared with a mould in plaster or wax of the cavity itself, they exhibit considerable differences, and, from the great variation which may take place in the thickness of the bones, this difference is not the same in degree in any two skulls.

Size of organs no criterion of energy.

Hollow as are the foundations of this theory, the materials which compose the superstructure will prove, on examination, to be still more frail and unsound. The whole fabric rests upon the validity of a single proposition, which in itself is extremely questionable, namely, that the size of an organ is in general a criterion of the energy with which its function is performed. If any doubt should remain as to its truth, the whole of the pretended discoveries relative to the functions of the several parts of the brain are shaken, and the fantastical edifice has no auxiliary prop to arrest its fall. So essentially, indeed, does the whole of this system depend upon the truth of a number of independent propositions, that if any one of them should turn out to be incorrect, the whole fabric must give way. The evidence in its favour, instead of being cumulative, is disjunctive. Where each proposition must be sustained by a separate series of proofs, as is the case here, it is evident that the chances of error must be multiplied in proportion to the number of steps we must ascend before we can arrive at the last conclusions. Let us, for example, examine the logic by which the above fundamental principle is deduced. "A large muscle," say they, "is stronger than a small one; and a large loadstone is more powerful in its attraction than a smaller one. Why should it not be the same with regard to the brain?" Thus again do they confide in a loose analogy, derived from another and a totally different part of the economy; and as if the organization and functions of the animal body were not sufficiently remote from the nature and operations of the human mind, the inanimate world is ransacked for the shadows of an analogy, which, when viewed through such a distance of intervening mist, may wear the semblance of reality. But the phantom must immediately vanish upon a near inspection. For the perfection of a refined and delicate instrument, such as must be that which is subservient to the operations of the intellect, innumerable conditions must concur; amongst which that of size, it is reasonable to suppose, is the least important. Delicacy of texture, fineness of organization, and harmony of adjustment between the several parts of its complex structure, must contribute infinitely more towards rendering it capable of performing its office, than superior magnitude; a circumstance which in itself is quite as likely to prove a source of imperfection, as to impart additional facility. Increase of size in the viscera of the body is often the indication of a diseased, instead of a healthy state. Small eyes, Professor Hufeland observes, see with more strength, and last longer than large eyes. Why may not this be also the case with the organs of the brain? But really, in our present state of ignorance as to the mode of operation by which they are subservient to the processes of intellect and sensation, all such reasonings *a priori* on their functions, as connected with their size, must be completely illusory.

P tical di ulties.

Even were we to admit so questionable a doctrine as that the energies of the parts of the brain are proportional to their magnitude, insuperable difficulties would still be opposed to the determination of their relative size in the living head; crowded as all these organs are in a narrow compass, and completely hid from our view by an irregular bony case which protects them from injury, and which is itself covered by a thick and variable layer of muscle and integument. Let us, however, for the sake of argument, suppose that the form of each organ within the skull can really be ascertained by external examination of the head; shall we allow it to be an easy task to determine the real character of the individual who is the subject of observation? Are we always able to discriminate between real and affected sentiment; or to mark with certainty the operation of all the various motives which constitute the springs of action? Is the transient glance of a passing observer sufficient for unravelling the complex web of our affections, or unveiling the secret and tortuous recesses of the human heart, so as to assign to each principle its precise sphere of agency? Can the most profound moralist, or acute metaphysician, pronounce with confidence what are the natural dispositions of any human being, knowing as we do, that these dispositions must have been changed or modified, exalted or subdued, perverted or refined, by the force of habit, education, example, and a multitude of other powerful causes, which, in his progress through life, have moulded his intellectual and moral constitution? Can he trace them through the guise of falsehood, artifice, and dissimulation, which so commonly hide his real character from the world, and which occasionally deceive the eye of the closest and most vigilant observer? Is it to the behaviour of a person who knows that he is watched; is it to the partial report of his friends; is it to the testimony of the individual himself, the most fallible of all, that the phrenologist is to trust for his knowledge of human character? Such, however, is the kind of *experience*, from which it appears that all the doctrines relative to the functions of the different parts of the brain have been derived; and it is in this experience, as in an impregnable fortress, that the adherents of the system make their last and most resolute stand. Quitting the airy region of theory, they fancy themselves posted upon a rock, secure against the insidious minings of scepticism, and bidding defiance to the rude assaults of argument. The appeal to the evidence of induction, as to the supreme authority in the court of philosophy, is made with confidence; and all the wild effusions of a bewildered fancy are presumed to be sanctioned by a supposed conformity with experience. You may speculate or reason, they exclaim, as you please; observation shows that such and such forms of the head, are the invariable concomitants of such and such predominant dispositions and faculties. Who will dare to set up his opinion in opposition to ascertained facts? We venture only to express strong doubts as to the reality of these facts, on which so much is made to depend, possessing the character of *general facts*, that is, of being the results of legitimate induction; and to suggest the expediency, previously to any admission of their truth, of inquiring not only into the manner in which the knowledge of these pretended facts has been obtained, and in which inductions from them have been made, but also into the talents and qualifications of the observer upon whose testimony we receive them for the exercise of this philosophical process. We should know in what spirit he conducted the inquiry; with what previous dispositions he examined the objects of his contemplation; what motives led him to these researches; and what interest he may have in the event. Experience, we should recollect, leads to very different results, according to the sagacity and good faith of the person who acquires it. Minds already prejudiced collect from it only a confirmation of their errors, and become, by its means, only the more obstinately wedded to their opinions. The sailor, steadfast in his belief that his whistling to the sea will raise a wind, or conjure up a storm, instead of being undeceived by experience, is only the more strengthened in his faith by the observations which it furnishes to him. In what a multitude of instances do we not find men deceiving themselves as grossly, when they draw inferences from what they see, if prepossessed with the expectation of meeting with a certain coincidence, or succession of events. How disposed are we all to disregard the exceptions to a preconceived rule, and to allow undue weight to every example that conforms to it. How willingly we repel the evidence that opposes, and how eagerly we catch at whatever corroborates our previous notions, especially when those notions have originated with ourselves, and are viewed as the darling offsprings of our own lucubrations.

Nature of the logic employed.

The discerning reader may already have perceived strong indications of this bias in the framers of the phrenological system, from the account we have already given of its origin and history, and of the kind of evidence on which they pretend to establish its doctrines. In order, however, to enable him to form a correct idea of the species of logic which they have been in the habit of employing and which they deem conclusive, and of the tone of mind with which they prosecute the investigation of subjects where nothing but the exercise of consummate prudence can secure from error, we shall conclude by offering one or two specimens of their mode of reasoning. We shall pass over the numerous stories, each more ridiculous than the preceding, of irresistible natural inclinations to wander from place to place, to commit murder, theft, infanticide, and other crimes, without any assignable object. We shall refrain from criticising the wonderful accounts of people who were insane on one side of the head only, and observed their insanity with the other side, and of others who heard angels sing, and devils roar, only on one side; nor shall we stop to investigate the curious case of the woman who declared in a court of justice, when accused of having destroyed her infant, that her sole motive for becoming pregnant was that she might enjoy the exquisite pleasure of killing her own child. Neither shall we venture to involve ourselves in that metaphysical labyrinth of the *thirty-five special faculties* into which they pretend to have analyzed the human soul; but content ourselves with examining, what in fact alone deserves examination, the sort of evidence brought forward to establish the relation between each faculty and a particular defined portion of the brain. We shall take, for this purpose, the following passage, which may be esteemed a fair specimen of the whole.

"Dr. Gall examined the head of a woman at Vienna who was known as a model of friendship. She suffered different changes of fortune; she became alternately rich and poor; but was attached to her former friends. Gall found the part of her head situated upward and outward from the organ of philoprogenitiveness, very prominent, and called it the organ of friendship. Our observations are not multiplied enough to enable us to decide positively on this organ; yet its seat appears to be more than probable. It *must* be inferiorly, because this faculty exists in the lower animals, and is a propensity. *For this reason* it belongs to their region of the head; and according to its mimical signs, and the motions of the head when it is active, it lies laterally and backward." Dr. Spurzheim, it is obvious, here reasons in a circle; for he assumes as true the thing to be proved, namely, that faculties of a certain class reside in a certain department of the head, and then applies it to establish the very proof on which the proposition itself ought to have rested. In order to render intelligible the latter part of his argument, the reader should be informed that Drs. Gall and Spurzheim believe, that, when any faculty of the mind is strongly excited, the action of the corresponding organ in the brain tends to raise that part of the head in which it is situated; so that the person has a propensity to lay his finger upon the nearest external part of the head, or sometimes to apply his hand to it, either to cool it when too hot, or to warm it when too cold, and that he is occasionally prompted to rub it in order to excite it when too sluggish. Thus, when we endeavour to recollect a name or a word, we unconsciously slap our foreheads, or rub the skin a little above the eyes, or perhaps higher still, just where the appropriate organ of memory is situated, that it may awake and exercise its peculiar faculty. When embarrassed by any difficulty, we gently stimulate in like manner, the organ of contrivance, by scratching the head at the part under which is the seat of *constructiveness*. The timid man scratches his head on the organ of courage behind his ear, as if he tried to rouse the feeble organ into activity. A proud man holds his head erect upon his shoulders, and raises himself upon his toes, for no other reason than because the organ of the sentiment lies at the very top of the head, and is therefore elevated by the action. A sense of danger, or the necessity of *circumspection*, leads all animals, man not excepted, to stretch their necks forwards horizontally, thus presenting the broad extent of that organ, as it were, in front. Devotion raises the head gently; and our adorations are all directed upwards, not because we regard the Deity as above, but because the organ of adoration is situated in the centre of the upper part of the head. When busied in deep contemplation, we cover the whole forehead with our hands, as it is there that the reflecting faculties are lodged; and, accordingly, when we reproach any one for his want of reflection, we put our hand to this part of the head; and exclaim, "he wants it here." If we try to recollect a date, we put into action the organ of time, which being situated over the eyebrows, and a little to one side, occasions an involuntary movement of the eyes upwards and towards the temples. In beating time to a musical air, we make the head oscillate from side to side, because the organs of tone as well as of time, being situated on each side, and being alternately in action, occasion these gesticulations. Sterne excelled in wit: and we find him represented in all his portraits with his head leaning on his hand, the fore-finger of which is placed on a particular part of the forehead. Dr. Spurzheim considers this as one of the proofs that the organ of wit occupies that very spot.

With minds capable of allowing any weight to such observations and imbued with such notions of the nature of philosophical induction, as are implied by the grave admission of such frivolous arguments as these, the investigation of the laws of nature must be an easy and a delightful task. With the abundant and all-powerful resources, which their indulgent method of reasoning is ever ready to supply, all difficulties may be smoothed away, all chasms immediately filled up, and all obstacles made to vanish the moment they arise. We need not be under any embarrassment at meeting with a skull exhibiting a particular prominence, although the faculty which should correspond to it be deficient. Doubtless the individual must have been strongly gifted by nature with this faculty, but education has long ago taught him to disguise or suppress its manifestations. It exists, perhaps, unknown to the person himself, and wants only a proper occasion for its being exhibited; or more probably the other faculties, having received a greater proportional developement, have overpowered and prevented it from appearing. If we find, on the contrary, a strongly marked faculty, without the corresponding shape of the head, we may still conclude that the organ exists notwithstanding; for the neighbouring organs, having received a greater extension, may have pushed it from its true place, or have grown up around it, and have concealed it from vulgar observation. Its not having been recognised is only a proof of want of skill in the observer; no doubt, it would easily have been discovered by the eye or hand of a true believer, and experienced cranioscopist; for it should be recollected that the differences are often very minute, and require the *tactus eruditus* for their detection. Besides, how can we be certain that the excellence of the faculty in question is not of an artificial or relative kind, and that it results from education, or the weakness of opposite faculties, rather than from nature? If all these expedients should fail us, we have nothing to do but to plunge into the depths of metaphysics, to refine and make subtle distinctions, or loosen the signification of a few words, till we have entangled ourselves in a wood, and lost sight of the real difficulty that had perplexed us. Thus will the theory be freed from all exceptions, and the induction be rendered complete. With such a convenient logic, and accommodating principles of philosophizing, it would be easy to prove any thing. We suspect, however, that on that very account, they will be rejected as having proved nothing.

Reply to criticisms

We have here re-printed the Essay on this subject which appeared under the head of Cranioscopy, in the Supplement to the last edition of the present work. We have done so because we have not seen any reason to alter our views. Since the year 1818, when that essay was written, replies have been attempted to some of our strictures; particularly by Mr. George Combe, in his "*Essays on Phrenology, and on the objections* *made against it,*" Edinburgh, 1819; and by Dr. Andrew Combe, in the *Phrenological Journal.* Although the conductors of this Journal have admitted that our Article was "regarded in the South as the most formidable attack Phrenology ever had to sustain,"[1] and have in so far paid us a compliment, we deem it unnecessary to answer, otherwise than very generally, their comments on the reasonings contained in it; because most of those comments are founded on a misconception of the scope of our arguments. When, for instance, we attempted to show, that, in establishing a philosophical principle, mere analogies ought not to be esteemed as equivalent to proofs, and when we maintained that they are still less to be relied on, when other analogies, of a contrary tendency, can be adduced on the other side of the question, we are represented by Dr. Combe as building our arguments on analogy, the very principle of which we were pointing out the fallacy, and repudiating the authority; and we are even charged with being guilty of the strange inconsistency of endeavouring to "refute direct inductive evidence, by that drawn from analogy."[2] Any reader who had paid the least attention to the train of reasoning we employed, must have perceived that our reasoning was diametrically the reverse of that which is imputed to us; and that we had even guarded against the possibility of mistake by the sentence concluding with the words, "all such reasonings *a priori* ...... must be completely illusory."

Arguments from human anatomy.

By the help of a mis-quotation, in which the qualifying adverb "nearly" is omitted, we are represented as having asserted, that the anatomy of the brain "will suit any physiological system equally well."[3] All the notions we can form of the nature of mental operations are so completely and essentially different from any of the affections of which we can conceive matter to be capable, that it is utterly impossible for us to understand the mode in which a connexion has been established between them; or to imagine any physical structure whatsoever, which shall, in the remotest manner, correspond with the metaphysical constitution of the soul. This, however, we may confidently assert, that amongst all the hypotheses which have been propounded respecting the correspondence between the corporeal instruments of the mind, and the mental faculties themselves, the one which is the least in accordance with the actual structure of the brain, is that devised by the phrenologists. Let a person, unacquainted with the anatomy of that organ, be shown the phrenological map of the cerebral regions, and let him be told, that to each corresponding subjacent portion of the brain is ascribed, as to a separate organ, a certain special mental function; one set of these organs being appropriated to the establishment of certain definite propensities, whilst another set gives rise respectively to various sentiments, and a third confers each its peculiar intellectual power; with what immeasurable surprise, on lifting up the bony covering which had concealed this expected assemblage of well defined organs, would he behold a uniform mass of pulpy substance, divided by furrows only, into serpentine but continuous convolutions, bearing no conformity or even similitude to the notions which his previous instructions had led him to form of distinct masses, divided from each other in accordance with their phrenological functions. Each of these pretended organs, far from being isolated in its structure, as its alleged isolated functions would imply, from the neighbouring parts, is seen to pass on, without visible boundary, to the next, by a continuity of cerebral substance. Turning round upon his instructor, would he not complain of being misled by him; and would he not require him to explain what intermediate function he can ascribe to those portions of the same convolution which occupy an intermediate place between two organs, to which he has already assigned functions utterly heterogeneous with one another? What lucid ideas can he convey of a function intermediate between *benevolence* and *imitation*, between *ideality* and *acquisitiveness*, between *cautiousness* and *adhesiveness*, or between *self-esteem* and *concentrativeness* or *inhabitiveness*, of which the respective organs are not merely contiguous, but pass insensibly into one another; and what is the curious and hitherto nondescript office that he will assign to those portions of the brain which occupy the central space at the junction of quintuple groups of organs, such as those of *ideality, acquisitiveness, constructiveness, tune,* and *wit,* all of which, though separated by the fancy of the phrenologist, have been by nature amalgamated into one continuous mass, undistinguishable by any visible lines of demarcation?

From comparative anatomy.

Not content with expressing his dissatisfaction at our failing to perceive the accordance between the structure of the human brain and the doctrines of phrenology, Dr. Combe extends his censure to our objection as to the evidence which observations on lower animals are supposed to afford in their favour; and to our assertion, that in the construction of their system "much was made to hinge" on facts derived from comparative anatomy. That the founders of the system placed great reliance on this kind of evidence, is a proposition sufficiently borne out by the testimony of Sir George Mackenzie, who, when speaking of inhabitiveness, remarks, "it is chiefly from observation on the lower animals that Dr. Spurzheim seems *to consider it as certain*, that there is such a faculty in man."[4] The fallacy of the reasoning by which comparative anatomy has been pressed into the service of phrenology, has been so ably exposed by Dr. Prichard, in his Treatise on Insanity, that we shall beg leave to borrow from that work the following judicious remarks. "The chief peculiarity," observes Dr. Prichard, "of Dr. Gall's psychological theory, was the attempt to draw a parallel between the animal qualities displayed by the lower animals and the individual varieties discovered among men." He proceeded "on the principle, that the innate or original faculties are common to man and the lower tribes of animals, to those at least which bear to man a general analogy in their organization, and especially in the structure of their nervous system; and sought for analogies in physical phenomena between the brute tribes, tracing in them the rudiments of those properties which, taken collectively, and in their highest degree of developement, form the human character, and which, in lower degrees and various relations, constitute the distinctive nature of each of the inferior kinds. The attempt was ingenious, and seemed to hold out the prospect of discovering curious and interesting relations; but it is necessary, before embarking in the inquiry, to determine whether the analogies are real or apparent; for it has been tacitly assumed that the supposed distinction between instinct and reason is unreal, and that the active principles are of the same kind in the higher and lower beings of the creation." "Perhaps metaphysical writers have been mistaken in laying down so broad a line of difference as they have established. We must, then, either elevate the brutes, or lower the superiority of mankind. Shall we say, after tracing the operations of a constructive instinct so wonderfully displayed by the beaver, or in the cells in which the bee lays up his honey, that an impulse to action precisely similar gave origin to the pyramids of Egypt, or to the building of Constantinople? Shall we venture to affirm that the tunnel under the Thames owes its existence to a burrowing propensity resembling that of the rabbit or the mole? Shall we conclude that Parry and Franklin sought the regions of the north, impelled by the instinct of the migratory rat; and that Magellan and De Gama traversed the Southern Oceans directed by an influence analogous to that which moves the flight of swallows? Or may we, with greater probability, determine that the lower tribes act under the guidance, not of blind instinct, but of enlightened reason; that metaphysicians were mistaken when they laid down the principle, 'Deus est anima brutorum,' that the birds of passage have some acquaintance with physical geography, and know the quarter where tropical warmth exists and genial breezes blow; that the bee has studied the exact sciences, and knows by calculation the form most advisable for its cells? In short, that there is a real analogy and correspondence between the mental faculties of man and the physical endowments of those creatures whom he conceitedly regards as his inferiors? If either of these positions can be maintained, there will be a sound foundation for the comparative pyschology of Dr. Gall and his followers; but if they should be rejected as improbable, we must admit that the analogies pointed out are remote, the things compared are different in kind, they agree only in external appearances; and we shall be brought to the conclusion that it has pleased the Author of nature to bring about corresponding results in the rational and irrational departments of the creation, by very different means."

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[1] *Phrenological Journal,* i. 166.

[2] *Ib.* i. 168, 169.

[3] *Ib.* i. 166.

[4] *Illustrations of Phrenology,* p. 92.

"If the evidence," continues Dr. Prichard, "brought in support of the organological system depends so entirely on universal coincidence between psychical properties and corresponding varieties in the structure of the nervous fabric, it must be important to determine whether there are any departments of the animal kingdom in which instincts and motive habitudes, and an entire psychical nature are displayed analogous to those of vertebrated animals, while yet in these departments there is no structure which can be said to bear resemblance to the complicated cerebral system of the so termed higher animals. In all the vertebrated kinds, the organization of the nervous fabric is in one principle, and the same fundamental type, with different degrees of developement, is traced in man and all other mammifers, in birds, reptiles, and fishes; but here the resemblance terminates, and the nervous system of molluscous animals and insects presented but few and remote analogies to that which belongs to the first great branch of the animal creation. It is, indeed, to be presumed that the nervous system, taken as a whole, fulfils, in the tribes last mentioned, the same offices as in those animals who have it enclosed in a bony case. Still, nothing exists at all resembling the complicated formation of a brain, with its lobes and convolutions. It is so much the more surprising to find the higher instincts, which had almost disappeared in fishes, display themselves with new splendour and variety in the brainless insects; creatures which, in the wonderful imitations of intelligence that govern their motive habits, rival, if they do not even exceed, the sagacity of the animals which most approximate to man."

"Now, if it should be established, that all those properties of animal life, approximating to intelligence, or bearing analogies so striking to the manifestations of mind, which, in one great division of the animal kingdom are assumed to be essentially connected with, and depending on, a particular system of organization, exist in another department, and display themselves in all the same various profusion, while the creatures belonging to this latter department are yet destitute of that system of organization, and of any thing that bears the resemblance to it, the advocates of Phrenology will be obliged to abandon that broad ground on which they have attempted to fortify their position. Within the more confined field which the vertebrated tribes alone present, it will be more easy to maintain such an assumed connexion of physical properties with a peculiar structure; or, rather, it is more difficult to disprove it when assumed. The general analogy which prevails throughout these tribes in the organization of their cerebral and nervous system, affords no room for so decisive a contradiction to the relation which the phrenologists would establish. Yet even within this field great and striking facts display themselves which are adverse to the hypothesis. Birds and reptiles, as Jacobi has observed, are nearly, if not wholly destitute of many cerebral parts, which in mammifers are held as of high importance for the manifestation of psychical properties, and yet they display psychical phenomena similar to those of mammifers. Whenever an undoubted and tangible fact can be laid hold of in the different proportional developement of cerebral parts, which can be brought into comparison with the relative differences of animal instinct, or of psychical properties in general, there is, if I am not mistaken, a manifest failure of correspondence between the two series of observations. This has been shown by Rudolphi in a striking manner, with respect to the cerebellum. The cerebellum, as this writer has observed, is found to lessen in its proportional developement as we descend in the scale of organized beings, without any corresponding diminution, and even with an increase of the propensity which Gall connects with it. How remarkably powerful is this instinct in birds; and yet how small is the cerebellum in the feathered tribes compared with its size in mammifers, and even in the latter, when we consider the magnitude which it attains in the human species? We observe those tribes in which the cerebellum nearly or entirely ceases to exist, obeying, nevertheless, the impulsion of instinct as blindly or devotedly as other kinds which have the organ in question remarkably developed. When we consider the great amplitude which the cerebellum attains in man, in comparison with its size in lower animals, we are obliged, if we really attach any importance to such a system of correspondence, to acknowledge some relation between this circumstance and the transcendant superiority of the human intellect, compared with the psychical powers of brutes."

"The facts which suggest themselves as we follow these trains of reflection, are scarcely to be reconciled with the phrenological theory: they seem, in the first place, to show, that the relations which in it are assumed to prevail through all nature are subject to vast exceptions; and as one great proof of the doctrine is the assumed universality of such relations, or the endowment of psychical properties in coextension with certain peculiarities of structure in cerebral parts, the exceptions endanger at least the outworks of the whole doctrine. When, in a more limited survey, we confine our observation to the sphere of vertebrated animals, and discover that variations in psychical phenomena take place without any evidence of corresponding changes in the structure of cerebral parts, and that these changes, on the other hand, occur without such alterations as we are led to anticipate in psychical properties, the system of organology seems to be shaken to its very centre."[1]

The ind tion imp fect.

Whilst the defenders of phrenology have, on the one hand, misrepresented the minor points of our argument, they have, on the other, disguised from their readers that it is on the insufficiency of the evidence adduced in support of their doctrine, that we rest our main objection to its credibility. We maintain, that they have taken only a one-sided view of what nature presents to our observation; that they have paid attention to those facts alone, which are confirmatory of phrenology, and shut their eyes to those which oppose it. In order to establish what they consider as the rule, they have collected together all the instances in its favour, and have passed over or suppressed all the exceptions. What we assert is, that more enlarged inquiry, conducted with a more entire devotion to the cause of truth, and a scrupulous rejection of error, would have shewn the latter to be at least equal, if not superior in number to the former. Our own observations, as far as we have pursued them, have led us to this conclusion; and it was on the result of these observations that our scepticism was principally founded. So frequent, indeed, are the exceptions, that even the founders of the system, Drs. Gall and Spurzheim themselves, on applying it practically, committed, as is well known, very glaring mistakes; giving frequently the most false judgments of the characters of various individuals. Have these mistakes, we may ask, been any where recorded by the phrenologists, and candidly set off against the instances in confirmation of their sagacity? What avails their collections of thousands of examples of coincidences, when the perhaps equally numerous instances of discordance are excluded from the catalogue? The fact, that the brain of Cuvier was of unusual magnitude, has been triumphantly proclaimed in all the publications on phrenology; but we are not aware that any phrenologist has brought forward the equally well-certified fact, that the brain of Sir Walter Scott was found on examination to be "not large."[1]

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[1] *Treatise on Insanity*, p. 465 to 474.

In like manner, a long catalogue of persons avowing their belief in phrenology, including many men of eminent talents and extensive knowledge, has been paraded before the public; but we have not yet seen any counter list of unbelievers prepared with the view of ascertaining, in a science professedly of pure observation, on which side the weight of authorities preponderates. The class of men who, from the nature of their pursuits, are perhaps best qualified to form a correct judgment in matters of this nature, are the members of the medical profession; yet how inconsiderable, compared with the total number, is the proportion of those belonging to that profession who, according to Mr. Combe's catalogue, have given in their adhesion. Sculptors, again, compose another class of men whose studies lead them more especially to the most minute and accurate knowledge of the external form of the human head; yet amongst the many who are at present engaged in the active exercise of their noble art, Mr. Combe has been able to bring forward the name of only one solitary individual as lending a countenance to phrenology.

Te mony adv e to phr ology.

"It is not enough," as Dr. Prichard very justly observes, "to have a few chosen coincidences brought forward by zealous partizans, who go about in search of facts to support their doctrine, and pass by, or really cannot perceive the evidence that ought to be placed in the opposite scale. The principles of the system ought to be applicable in every instance. The phrenologists, however, aware of numerous and striking exceptions, elude their evidence by asserting, that when a certain portion of the cranium and of the brain is greatly developed, while the faculty there lodged has never been remarkably distinguished, it nevertheless existed naturally, though the innate talent, for want of proper cultivation, has never been displayed; the predominant organic power was never discovered by the owner, though, according to the principles of the doctrine, with this organic power a proportional impulse to exertion, or an instinctive energy is combined, which communicates of itself a strong and irresistible tendency to particular pursuits. When, again, a strongly marked propensity, or a decided talent has been manifested without any corresponding amplitude of structure, it is in like manner pleaded, that by sedulous exercise and culture, a natural deficiency has been overcome. Thus the phrenologist avails himself of a double method of elusion; his position, like the cave of Philoctetes, affords him an escape on either side; and in one direction or another he contrives to baffle all the address of his opponents.

"If, however, the testimony of facts in a great scale should be found adverse to the alleged coincidences, or to the correspondence of given mental equalities with certain conditions of the brain, phrenology will not continue to make proselytes, and it will be ultimately discarded as an hypothesis without foundation. At present, most inquisitive persons seem to be in doubt on this subject, and to be looking out for evidence. I have taken every opportunity that has occurred to me for many years of making inquiries of persons who had a great field of observation within their reach, what had been the result of their experience on this subject. Many of the persons have been physicians, who were superintendants of extensive lunatic establishments. Some of them had been men who had addicted themselves to the study of phrenology, and were predisposed to imbibe the opinions of its authors; some have been persons distinguished by their researches in the anatomy and physiology of the brain and nervous system. Among these I do not remember to have found one who could say that his own observation had afforded any evidence favourable to the doctrine. Yet we should imagine, that a man who lives amidst hundreds of monomaniacs must have constantly before his eyes facts so obvious that he could not be mistaken in their bearing. Some hundreds, and even thousands of such persons have passed a part of their lives under the inspection of M. Esquirol, who possesses most extensive resources for elucidating almost every subject connected with the history of mental diseases, and has neglected no inquiry which could further the attainment of that object. The result of his observations will be allowed to be of some weight on the decision of this question, in which the appeal is principally to facts of the precise description of those with which he has been chiefly conversant. At his establishment at Ivry he has a large assemblage of crania and casts from the heads of lunatics, collected by him during the long course of his attendance at the Salpêtrière, and at the Royal Hospital at Charenton, which is under his superintendance. While inspecting this collection, I was assured by M. Esquirol, that the testimony of his experience is entirely adverse to the doctrine of the phrenologists; it has convinced him that there is no foundation whatever in facts for the system of correspondences which they lay down between given measurements of the head and the existence of particular mental endowments. This observation of M. Esquirol was made in the presence of M. Mitivié, physician to the Salpêtrière, and received his assent and confirmation. M. Foville, physician to the extensive lunatic asylum at St. Yon, gave me a similar assurance. There are few individuals in Europe whose sphere of observation has been so extensive as that of M. Esquirol and M. Foville, and certainly there are none whose science and habits of observation better qualify them to be witnesses in such a subject of inquiry; but testimonies to the same result may be collected from unbiassed witnesses, whose evidence taken collectively may have nearly equal weight. Among these there are men unscientific, though capable of correct and unprejudiced observation, as well as anatomists and physiologists. In the number of the latter is Rudolphi, who declares that he has examined many hundreds of brains without finding any thing that appeared to him favourable to the phrenological theory."[2]

Evaded by the phrenologists.

The mode in which Dr. Combe evades the force of the strong testimony here adduced, is quite characteristic of the disposition to be found amongst confirmed phrenologists, of resolutely rejecting all evidence that militates against the system they have adopted. Thus, he says, in reference to the passage we have just quoted, "If Dr. Prichard believes that the intelligent and benevolent Esquirol, is that person," (namely, one "competent to form a judgment on the subject,") and if his collection of crania and casts be the hostile evidence which is relied on, this only proves, in a forcible manner, that Dr. Prichard is himself not competent to judge, or that he has not taken time either to examine the collection of crania, or to ascertain the competency of Esquirol and Metivié, to decide on the merits of the question on which they volunteered an opinion."[1] We cannot help remarking here, that, on another occasion, when criticising the suggestion we threw out, in the Essay on Cranioscopy, of the propriety of inquiring into the talents and qualifications of observers before admitting the truth of the facts received on their testimony, a very different language was held. "When they" (the advocates of phrenology) "affirm that the subjects of observation are patent to the whole world, who have eyes to see, and understandings to comprehend; and when they say, compare manifestations with cerebral developement, and you are at the bottom of the problem yourself; what need for inquiry into their talents and qualifications to observe?" "When Gay Lussac hears that Sir Humphry Davy has made a discovery in chemistry, and reads Sir Humphry's statement of the way in which it was made, does he begin by inquiring first, whether it be possible to make the discovery at all, seeing natural substances are 'so changed and modified, exalted and subdued' by a multitude of powerful causes? And, after settling this point, does he, in the second place, proceed to inquire into Sir Humphry Davy's talents and qualifications as a chemist, and into his capacity to make the discovery, and then believe it, or not, according to the result of this investigation? No man who knows the first rudiments of philosophy would follow so absurd and preposterous a course. What should we think of Gay Lussac's refutation of Sir Humphry's discovery, founded on a metaphysical inquiry into the possibility of making it, and into the 'talents and qualifications' of the discoverer? We should pity him for his ignorance of the rudiments of philosophy."[2]

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[1] *Life of Sir Walter Scott*, by Lockhart, vol. vii. p. 395, note.

[2] *Treatise on Insanity*, pp. 476, 477.

This happy talent, possessed by the champions of phrenology, of shaping their course either one way or the opposite, according as it may suit the convenience of the occasion, enables them, at one time, to proclaim, that the evidences of their science are palpable and demonstrative, that the field of nature is open to all inquirers, that "every one who has eyes may see" and judge for himself; and at another, when such judgment is against them, they can turn round, and allege that in order to arrive at the truth a peculiar discretion and tact, acquired by long experience and careful appreciation of minute and hair-breadth differences of size is necessary. They can then declare that the observer who has not arrived at the same conclusions as themselves, is doubtless incompetent to the task he has attempted; and that his testimony, being of no value, ought to be wholly set aside.

Process of verification.

Let it be borne in mind, then, by the practical inquirer into the truth of phrenology, that he will not be esteemed qualified to verify its doctrines, unless he be previously deeply versed in the new system of psychology, can assign to each of the thirty-five special and primary faculties of the soul its sphere of operation, and has acquired a readiness in unravelling their multifarious combinations, so as to analyze, by this subtile metaphysical chemistry, all human qualities into their proximate and ultimate elements, refer all actions to their proper innate impulses, and assign the proportions of the various ingredients which are mixed up in the formation of the character of each individual. No one is competent to excel in this new branch of philosophy who doubts the possibility of appreciating the intensities of moral or intellectual qualities by geometrical measurements, on scales divided into tenths and hundredths of inches. The young and ardent phrenologist, who after having applied his callipers to the skull subjected to his examination, and taken a note of the dimensions of each of the thirty-five organs, proceeds to verify his observations by comparing them with the character of the possessor of those organs, will never fail to meet with *wonderful coincidences*, sufficient to give him the greatest satisfaction, and confirm him in the persuasion that he possesses the real key to the secrets of nature in the hitherto recondite science of mental philosophy. A moderate share of dexterity in reconciling apparent discrepancies will suffice to ensure a preponderance of favourable evidence; since, fortunately, there have been provided in the brain different organs, sometimes of similar and sometimes of opposite properties, capable, by a little adjustment of *plus* or *minus* on either side of the equation, of furnishing the requisite degrees of the mental quality sought for, and of thus solving every psychological problem. We shall suppose, for instance, that he is inspecting the head of a person known to have given credit to the prophecies of a weather almanack; he finds, on reference to the "system of phrenology," that a belief in astrology is the offspring of No. 16, that is, *ideality;* so that if this organ happen to be sufficiently large, the phenomenon is at once accounted for. But if it be not, our phrenologist will have another chance; for he will probably discover it to arise from the dimensions of No. 15, which inspires *hope*, the source of the *propensity to credulity*. Habitual *irresolution* may result either from the magnitude of No. 12, or the diminutiveness of No. 18; thus affording very great convenience for making our observations of the character square with those of the dimensions of the organs, and *vice versa*. If, again, the magnitude of the organ of *combativeness* accord with the manifestations of pugnacity given by the individual, it is well, and we need inquire no farther, but set it down at once as an irrefragable proof of the accuracy of phrenological determinations. Should the correspondence, however, not prove satisfactory, the organ being large for instance, and the manifestation small, we have then further to examine the dimensions of the organ of *caution*, the influence of which is to moderate and check the operation of the former; and we shall perhaps find this organ sufficiently large to account for the phenomenon. Both these organs may be large, or both small, or the first may be small and the second large, or the converse; and other modifications of action may result if either one or both be only of moderate size, allowing great latitude of choice in the assignment of motives. Should we be so unfortunate as to exhaust all the combinations without meeting with the success we desire, there is still an abundance of auxiliary faculties of which we may avail ourselves with advantage. If we were to explain the fact of the individual in question having accepted a challenge, he might have been inspired by *combativeness*, whose voice was "still for war," or goaded on by *destructiveness*, to fight that he might destroy; *firmness* may have urged him to persevere by the consideration that he had previously resolved it, and *concentrativeness*, by rivetting his attention to the subject, may have screwed his courage to the sticking place; or he may have been prompted by *imitation* to follow the example, or by *approbation* to gain the applause of his friends. We have also to take into the account the countervailing influence of faculties which are pulling in the opposite direction, and qualifying the combined powers of the former incentives: And should *cautiousness* not be in sufficient force, we are to consider the power of *conscientiousness*, which preaches forbearance, meekness, and forgiveness; of *veneration* which appeals to the high authority of religion and of law; of *benevolence* restraining the hand from inflicting pain and death; of *approbation*, who qualifies her sanction by raising other voices condemnatory of the deed; and last, though not least, the *love of life* which recoils with instinctive dread from the possible catastrophe. Drawing, then, a diagram of all these component moral forces, in their proper directions, and suitable proportions, it will not be very difficult to obtain by this artificial dynamico-phrenological process, the exact resultant which corresponds with the actual fact to be explained.

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[1] *Phrenological Journal*, viii. p. 654.

[2] *Essays on Phrenology*, p. 71.

Lest it should be imagined that the above description is a caricature of the new method of philosophizing, so admirably calculated to establish the truths of phrenology, we shall beg to quote the following passage from Sir George Mackenzie's *Illustrations* as an example of this satisfactory process of ratiocination.

"In discussing the conjectured faculty of inhabitiveness with Mr. Combe, he had the goodness to make us acquainted with a case, in which *locality* and *inhabitiveness* were both very moderate in developement, but the *propensity to wander*, as he informed us, very powerful. Dr. Spurzheim mentions this propensity as belonging to *locality*, and he states several remarkable cases in which the organ was much developed, and the propensity strong. The case referred to by Mr. Combe was, on this account, interesting; and we will state the result of our inquiries into the particulars, for the purpose of giving an example of the caution with which we ought to receive the description of any case brought in opposition, since it sometimes appears to be necessary even among friends.

"The young man to whose case we refer, had a very strong desire to adopt a seafaring life, contrary to the wishes of his friends. It occurred to them, that a voyage up the Baltic, during the stormy months of October and November, might have the effect of giving him a disgust to the profession for which he showed so ardent a desire. He suffered so many privations and hardships, that he yielded to the wishes of his friends, although the desire to go to sea continued as strong as ever. On proposing a few questions, we found that the propensity was confined to *being at sea;* that this propensity did not originate in a desire to wander; for neither travelling on land, nor mere change of place, would have gratified the propensity. At the same time, the person referred to declared, that regular voyages to the same place would not have satisfied him. The propensity had haunted him as long as he could remember any thing. Being anxious himself to contribute to the unravelling of what appeared mysterious and irreconcilable to the system, he stated that he used to go once or twice a-day to examine the mechanism and rigging of ships in Leith harbour, an employment of which he was passionately fond; and long before he commenced his trial voyage, he had become familiar with the names and uses of every part of a ship, and of the rigging. He was fond of machinery, and has often amused himself by making models of ships; and his mechanical turn was so strong, that he had constructed a model of machinery, by which a ship's motion may be applied to work the pumps. This mechanical propensity, and his early attachment to naval machines, together with *firmness*, appear to us to have given rise to his desire for a sea-faring life. *Courage* might also have prompted his wish to enter the navy. Thus the supposed propensity to wander appeared not to exist; and it was found that a mechanical genius, an early attachment[1] to the mechanism of a ship, *perseverance, courage*, and probably also love of *approbation*, or ambition, and *ideality*, all of which were well developed in the individual referred to, combined to inspire the desire to enter the navy." *(Illustrations of Phrenology*, p. 170.)

It is to be lamented that, at the period when this elaborate investigation was undertaken, the organ of *wonder* had not yet been made; for as one of the functions of this organ, according to Mr. Combe, is to "incite young men to chuse the sea as a profession," much light would have been thrown upon the object of the inquiry by a critical examination of its dimensions compared with those of all the other organs which were taken into consideration as combining their influence in producing the result.

There is this very remarkable peculiarity in the pursuit of phrenology, that the student is perplexed, not with the difficulties, but with the facilities it affords for explaining every phenomenon. The pliability of its doctrines is exemplified, not merely in the analysis of motives, but likewise in the influence which we are allowed to ascribe to the habitual exercise, or education of the faculties. The observed magnitudes of the respective organs indicate, not the acquired, but the natural powers, sentiments, and propensities. Now, the character of the individual is the joint result of the force of natural endowments, and of the amount of moral and intellectual cultivation which has been bestowed upon them. But can we ever know enough of the minute history of the progress of the mind of any individual to enable us to form a correct estimate of the relative power of these two elements, which have, in the formation of each respective faculty, combined their operations? If it be true that an organ may be the seat of a faculty varying in its activity according to the occasions which call it forth, by what physical criterion can we distinguish the active from the dormant conditions of that organ? Unless we can draw, with precision, these distinctions, it is evident that the ground of all cranioscopical observation is cut from under us.

It may be indeed alleged, that at all periods of life, and even after the bones of the skull are consolidated, the organs increase or diminish in size according to the exercise or disuse of the faculty associated with it, whether such change may have been brought about by voluntary training, or by the discipline of circumstances; and certainly, if such were the fact, our experience would repose on a much surer basis, than if the form of the organs merely retained the stamp originally impressed upon them by nature. But the hypothesis that the cerebral organs acquire additional size by the exercise of their powers was positively rejected as untenable by Dr. Spurzheim, as we have heard him publicly declare; and it is, we believe, repudiated by the generality of phrenologists.

Progress of phrenology accounted for.

We do not think it difficult to account for the progress which phrenology has made amongst the very numerous class of persons who find in it a source of agreeable occupation, giving exercise to their ingenuity in discovering striking coincidences, and gratifying their self-complacency by inspiring them with the fancy that they are penetrating far into the mystic regions of psychology. For the last twenty or thirty years, various popular writers, and lecturers without number, have been displaying their powers of elocution, exercising their skill in the critical examination of developements, and expounding the doctrines of the new philosophy to wondering and admiring audiences. With all these advantages and appliances to boot, the wonder seems to be, not that phrenology has met with the success of which so much boast is made, but that it has not speedily gained the universal assent; for had it been a real science, like that of Chemistry and other branches of Natural Philosophy, founded on uniform and unquestionable evidence, it could not have failed, by this time, of being generally recognised as true.

When we consider that the present age is not one in which there is any lack of credulity, or in which a doctrine is likely to be repudiated on the score of its novelty or its extravagance, we cannot but smile at the complaints of persecution uttered by the votaries of the system of Dr. Gall, and at the attempts they make to set up a parallel between its reception in this country, in these times, and that which, two centuries ago, attended the speculations of Galileo, and subjected him to the tyrannous cognisance of the Inquisition; or to establish an analogy between the dogmas of phrenology and the discoveries of the circulation of the blood, and of the analysis of light, which have immortalized the names of Harvey and of Newton.

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[1] "Dr. Spurzheim has shown, that the faculty of attachment extends its influence to inanimate things, as well as to animate beings."

Phrygia.

PHRYGIA, a country in Asia. The origin of the name is uncertain; but some say that it was derived from the river Phryx, now Sarabat, which divides Phrygia from Caria, and empties itself into the Hermus; whilst others think that it was so called from Phrygia, the daughter of Asopus and Europa. The Greek writers inform us that the country took its name from the inhabitants, and these from the town of Brygium in Macedonia, whence they first passed into Asia, and gave the name of *Brygia* or *Phrygia* to the country where they settled. Bochart is of opinion that this tract was called Phrygia from the Greek verb φρυγειν, *to burn* or *parch*, which, according to him, is a translation of its Hebrew name, derived from a verb of the same signification.

Nor are the opinions of authors less various as to the ancient boundaries of this country; an uncertainty which gave rise to an observation of Strabo, that the Phrygians and Mysians had distinct boundaries, but that it was scarcely possible to ascertain them. The same writer adds, that the Trojans, Mysians, and Lydians, are, by the poets, all blended under the common name of Phrygians, which Claudian extends to the Pisidians, Bithynians, and Ionians. Phrygia proper was, according to Ptolemy, bounded on the north by Pontus and Bithynia; on the west by Mysia, Troas, the Ægean Sea, Lydia, Mæonia, and Caria; on the south by Lycia; and on the east by Pamphylia and Galatia. It lies between the 37th and 41st degrees of north latitude, and extends in longitude from 56 to 62 degrees. The inhabitants of this country, mentioned by Ptolemy, are the Lycaones and Anthemisenii towards Lycia, and Moccadelis or Moccadine; the Cyddeses or Cydisses towards Bithynia; and the Peltini or Speltini, the Moxiani, Phylacenses, and Hierapolitæ, between these. To the latter may be added the Berecyntes, mentioned by Strabo.

Phrygia is commonly divided into the Greater and Lesser, called also Troas. But this division did not take place till Troas had been subdued by the Phrygians; and hence it is rather considered by some Roman writers as a part of Phrygia, than Bithynia, Cappadocia, or any other of the adjacent provinces. In after ages the Greater Phrygia was divided into two districts or governments; one called Phrygia Pacatiana, from Pacatianus, who, under Constantine, was the *præfectus prætorio* of the East; and the other Phrygia Salutaris, from some miraculous cures supposed to have been performed there by the archangel Michael.

This country, and indeed all Asia Minor, was in ancient times greatly celebrated for its fertility. It abounded in all sorts of grain, being, for the most part, a champaign country covered with a deep and rich soil, and plentifully watered by small rivers. In some parts it produced bitumen and other combustible substances. The plains were also well stocked with cattle and pasture grounds. The air was anciently deemed pure and wholesome, although it is now in some parts thought extremely bad, great part of the country lying uncultivated.

Phrygia Major anciently contained several cities of great celebrity, such as Apamea, Laodicea, Hierapolis, Gordium, &c. There were also in it some famous rivers, such as the Marsyas, the Mæander, &c. The Mæander is now named Madre or Mindre, and was much celebrated by the ancients for its windings and turnings; whence all such windings and turnings have been denominated meanders.

The Phrygians accounted themselves the most ancient people in the world. Their origin, however, is extremely uncertain. Josephus and St Jerome say that they were descended from Togarmah, one of Gomer's sons; and that they were known to the Hebrews under the name of Tigrammanes. The heathen authors derive them from the Brygians, a people of Macedonia. But this is a mere conjecture, being totally unsupported, except by the similarity of names. Bochart thinks that the Phrygians were the offspring of Gomer the eldest son of Japhet, the word Phrygia being the Greek translation of his name. Josephus makes Gomer the father of the Galatians; but by the Galatians he must necessarily mean the Phrygians inhabiting that part of Phrygia which the Galatians had made themselves masters of; the descendants of Gomer having been placed by Ezekiel to the northward of Judæa, near Togarmah (which Bochart takes to be Cappadocia), long before the Gauls passed over into Asia. We are willing to let Gomer enjoy the fine country which Bochart has been pleased to assign him, and concede to him the honour of being the progenitor of the Phrygians, since we know no other person upon whom it can be conferred with any degree of probability.

The ancient Phrygians are described as superstitious, voluptuous, and effeminate, without any prudence or foresight, and of such a servile temper that nothing but stripes and ill usage could make them perform their duty; a character which gave rise to several trite and well-known proverbs. They are also said to have been the inventors of divination by the singing, flying, and feeding of birds. Their music, commonly called the *Phrygian mood*, is alleged by some as a proof of their effeminacy.

The government of this country was certainly monarchical; for during the reigns of some kings, Phrygia was subject to one prince. Ninnacus, Midas, Manis, Gordius and his descendants, were undoubtedly sovereigns of all Phrygia. But some time before the Trojan war we find this country divided into several petty kingdoms, and different princes reigning at the same time. Apollodorus mentions a king of Phrygia as contemporary with Ilus king of Troy. Cedrenus and others speak of one Teuthrans, a king of a small country in Phrygia, whose territories were ravaged by Ajax, whilst he himself was slain in single combat, his royal seat laid in ashes, and his daughter, named Tecmessa, carried away captive by the conqueror. Homer makes mention of Phorcys and Ascanius, both princes and leaders of the Phrygian auxiliaries who came to the relief of Troy. Tantalus, a prince no less famous for his great wealth, than infamous for his covetousness and other detestable vices, was only king of Sipylus and its adjacent district. That Phrygia was subdued either by Ninus, as Diodorus Siculus informs us, or by the Amazons, as we read in Suidas, is not sufficiently established. Most authors who speak of Gordius tell us, that the Phrygians, having sent to consult an oracle in order to learn how they might put an end to the intestine broils which divided their country into many factions and parties, received for answer, that the most effectual means to deliver themselves and their country from the calamities under which they groaned, was to commit the government to a king; an advice which they followed accordingly, and placed Gordius on the throne.

Apamea was the chief emporium of all Asia Minor. Thither resorted merchants and traders from all parts of Greece, Italy, and the neighbouring islands. Besides, we know from Syncellus, that the Phrygians were for some time masters of the sea; and none but trading nations ever prevailed on that element. The country produced many choice and useful commodities, which afforded considerable exports. They had a safe coast, convenient harbours, and whatever may incline us to think that they carried on a considerable trade. But as most of the Phrygian records are lost, we will not dwell on conjectures so difficult to be ascertained.

We have no remains of the Phrygian laws; and in regard to their learning, as we are informed that for some time they enjoyed the sovereignty of the sea, we may at least allow them a competent skill in geography, geometry, and astronomy, besides their reputed knowledge of music. Some have been of opinion that the Phrygian language bore a great resemblance to the Greek; but the contrary is manifest from the few Phrygian words which have been transmitted to us, and carefully collected by Bochart and Rudbechius. To these we may add the authority of Strabo, who, after attempting to derive the name of a Phrygian city from the Greek, concludes that it is a difficult matter to discover any similitude between the barbarous words of the Phrygian language and the Greek. The Phrygian tongue, after the experiment made by Psammetichus, king of Egypt, was looked upon by the Egyptians as the most ancient language of the world. But other nations, particularly the Scythians, refused to submit to their opinion, as founded on an argument of no real weight. "As the two children," say they, "had never heard the voice of any human creature, the word *bec*, or *bekkos*, the first they uttered, was only an imitation of the goats that had suckled them, and happened to be a Phrygian word signifying *bread*."

As the Phrygians were superstitious, their idols were consequently numerous. The chief of these was Cybele, who went by a variety of names. They also worshipped Bacchus under the name of Sabazios, and called his priests Saboi.

The history of their kings is dark and uncertain, and the dates of their several reigns and actions cannot now be fixed. We refer such of our readers, therefore, as wish to know what is certain respecting them, to the Ancient Universal History.

PHRYGIANS, a Christian sect. See CATAPHRYGIANS and MONTANISTS.

PHRYNE was a celebrated courtezan, who flourished at Athens about 328 years before the Christian era. She was mistress to Praxiteles, who drew her picture, which was one of his best pieces, and placed in the temple of Apollo at Delphi. We are told that Apelles painted his Venus Anadyomene after he had seen Phryne on the sea-shore naked, and with dishevelled hair. Phryne became so very rich by the liberality of her lovers, that she offered to rebuild, at her own expense, Thebes, which Alexander had destroyed, provided this inscription were placed on the walls, *Alexander diruit, sed meretrix Phryne refecit;* but her offer was rejected.

PHRYNICHUS, a tragic poet of Athens, was the son of Polyphradmon or Phradmon, and the disciple of the celebrated Thespis, being a little earlier than Æschylus. He gained the tragic prize, B. C. 511, and is said to have introduced several improvements into the dramatic art, bringing on the stage female characters, and making the actors adopt the use of masks instead of disfiguring their faces with the lees of wine. Suidas mentions the names of nine of his tragedies, and ascribes to another Phrynichus, son of Melanthes, a tragedy entitled *The Sack of Miletus*, which recalled so forcibly to the Athenians the melancholy fate of that Greek city, that they punished the poet by a fine of a thousand Attic drachmæ, or, according to Ælian, banished him from Athens. As the son of Phradmon is said to have died in Sicily, probably at the court of Hiero, where Æschylus also took refuge, it is not unlikely that this tragedy may have been his production.

PHRYNICHUS, one of the last writers of the old comedy at Athens, flourished B. C. 435, and was the contemporary of Eupolis, Euripides, and Aristophanes. He obtained the second prize, B. C. 405, the year before Athens was taken by the Spartans. Plutarch states, that in one of his plays he defended Alcibiades when he was accused of having mutilated the statues of Hermes. Aristophanes ridicules Phrynichus for introducing too frequently on the stage characters in low life. The fragments of Phrynichus have been collected by Morel, *Ex Veterum Comicorum Fabulis quæ integra non extant*, Par. 1553; by Hertelius, *Vetustissimorum Comicorum Sententiæ*, Bâle, 1560; and by Grotius, *Excerpta ex Tragœdiis et Comœdiis, Gr. Lat.* Par. 1626.

PHRYNICHUS ARRHABIUS, a Greek grammarian, was a native of Bithynia, and flourished about the middle of the second century, in the reigns of Marcus Aurelius and of Commodus. He had devoted much time to the study of the Greek language, which he pretended to speak and write in the utmost purity. He made a collection of all the words used in the Attic dialect, of which an abridgment has been preserved under the title *Eclogæ Nominum et Verborum Atticorum.* He rejected every word which could not be found in some work of Plato, Thucydides, or Demosthenes, and was particularly severe on the style of Menander. This little work, published first by Calliergi, Rome, 1517, was reprinted at Venice, 1524; but the best edition is that of C. A. Lobeck, with learned annotations, Leipzig, 1820, 8vo. Phrynichus had also collected examples of every different kind of style, in the form of a dictionary, divided into thirty-five books, which he dedicated to the Emperor Commodus. This compilation, entitled *Apparatus Rhetoricus sive Sophisticus*, was still extant in the time of Photius. Some fragments remain, which have been published by Montfaucon in the *Bibliotheca Coisliniana*, p. 465–69.

PHRYXUS, in fabulous history, was a son of Athamas, king of Thebes, by Nephele. When his mother was repudiated, he was persecuted with the most inveterate fury by his stepmother Ino, because he was to sit on the throne of Athamas, in preference to the children of a second wife. His mother, or, according to others, his preceptor, apprised him of Ino's intentions upon his life; and, the better to make his escape, he secured part of his father's treasures, and privately left Bœotia with his sister Helle, to proceed to the court of Æetes, king of Colchis. They embarked on board a ship, or, as we are informed by the poets and mythologists, they mounted on the back of a ram, whose fleece was of gold, and proceeded on their journey through the air. The height to which they were carried rendered Helle giddy, and she fell into the sea. Phryxus gave his sister a decent burial on the sea-shore, and after he had called the place *Hellespont*, from her name, he continued his flight, and arrived safely in the kingdom of Æetes, where he offered the ram on the altar of Mars. The king received him with great tenderness, and gave him in marriage Chalciope, his daughter, by whom he had Phrontis Melas and Argos Cylindrus, whom some call Cytorus. He was afterwards murdered by his father-in-law, who envied him the possession of the golden fleece; and Chalciope, to prevent her children from sharing their father's fate, sent them privately from Colchis to Bœotia, the jealousy or resentment of Ino, who was then dead, being no longer to be dreaded. The fable of the flight of Phryxus to Colchis on a ram has been explained by some, who observe, that the ship in which he embarked was either called by that name, or carried on her prow a figure of that animal. The fleece of gold is accounted for by observing that Phryxus carried away immense treasures from Thebes. Phryxus was placed after death amongst the constellations of heaven. The ram which carried him to Asia is said to have been the fruit of Neptune's amour with Theophane the daughter of Altis. This ram the gods had given to Athamas to reward his piety and religious life; and Nephele procured it for her children, just as they were going to be sacrificed to the jealousy of Ino. The murder of Phryxus was some time afterwards amply revenged by the Greeks, having occasioned the famous expedition under Jason and many of the princes of Greece, which had for its object the recovery of the golden fleece, and the punishment of the king of Colchis for his cruelty to the son of Athamas.

PHUGWANA, a large walled town of Hindustan, in the province of Lahore, belonging to the Sikhs. It is situated between the Beyah and the Sutelege Rivers, south-east from Jallinder, in a fertile and well-cultivated plain, which produces wheat and other grains, and also the sugar-cane.

PHYLACTERY, in general, was a name given by the ancients to all kinds of charms, spells, or characters, which

Phylactery
||
Physic.

they wore as amulets, to preserve them from danger or disease.

Phylactery particularly denoted a slip of parchment, on which was written some text of Scripture, generally of the decalogue, which the more devout people amongst the Jews wore on the forehead, the breast, or the neck, as a mark of their religion. The primitive Christians also gave the name of *phylacteries* to the cases in which they enclosed the relics of their dead. Phylacteries are often mentioned in the New Testament, and appear to have been very common amongst the Pharisees in our Lord's time.

PHYLLIS, in fabulous history, was a daughter of Sithon, or, according to others, of Lycurgus, king of Thrace, by whom Demophoon, the son of Theseus, at his return from the Trojan war, was received and hospitably entertained. Phyllis became enamoured of him, and did not find him insensible to her passion. After some months of mutual tenderness and affection, Demophoon sailed for Athens, whither his domestic affairs recalled him. He promised faithfully to return before a month had expired; but either a dislike for Phyllis, or the irreparable situation of his affairs, obliged him to violate his engagement; and the queen, growing desperate on account of his absence, hanged herself, or, according to others, threw herself from a precipice into the sea and perished. Her friends raised a tomb over her body, where there sprung up certain trees, the leaves of which at a particular season of the year suddenly became wet, as if shedding tears for the death of Phyllis. According to an old tradition mentioned by Servius, Phyllis was changed by the gods into an almond-tree. Some days after this metamorphosis, Demophoon revisited Thrace; and when he learned the fate of Phyllis, he ran and clasped the tree, which suddenly shot forth, and blossomed, as if still sensible of tenderness and love.

PHYSHARMONICA, a musical instrument, in which the immediate sonorous bodies are springs of steel or of brass, thrown into vibration by a current of air impelled against them. It was invented by Hackel, at Vienna, and is an instrument of the same kind as the æolodicon, or æoline, which was previously invented by Eschenbach, a Bavarian. The same sort of instrument was reproduced in England a few years ago. On the Continent it has been introduced into organs as a very efficient stop. See the article Music for some notices of similar instruments.

PHYSIC, PRACTICE OF.

We feel that it would be unsuitable to occupy the pages of a work like this with an epitome of the Practice of Physic, composed either on such a scientific plan as would adapt it to members of the medical profession, or in such a more popular style as would be requisite were it addressed to general readers. But there are some topics connected with the study and exercise of the medical profession, from a discussion of which general readers may derive, we conceive, both interesting and useful information. In particular, it seems extremely desirable that the public should entertain more accurate notions than generally prevail, as to the nature and extent of the *difficulties* medical men have to encounter in the exercise of their profession;—difficulties that are in part, no doubt, common to medicine with all other practical sciences; but which must also be attributed in a great measure to the peculiar character of the subject itself. By being better informed with regard to the nature and sources of these difficulties, the public would be better able to judge of the qualifications they ought to look for in those to whom they intrust their health; more reasonable in the expectations they form of the benefits to be derived from medical assistance; and less easily estranged than they are too apt to be, from a just reliance on persons of judgment and skill, by the boastful pretensions of ignorant and possibly uneducated empirics.

When the physician is called to a patient, there are two objects to which his attention is successively directed; *first*, to ascertain with what disease his patient is affected; and, *second*, to determine the method of treatment best suited for its cure or alleviation. In the following article we purpose to consider what are the means that the practitioner employs for effecting the first of these objects—for determining in practice what the disease is with which he has to contend; and, in particular, to take a general view of the difficulties he has to encounter in endeavouring to arrive at a correct judgment on this subject.

A knowledge of the disease with which his patient is affected, the medical practitioner can hope to attain only by an accurate observation of the morbid phenomena or symptoms that manifest themselves, combined with or followed up by a careful consideration of the pathological conditions from which his own experience and that of others has shown that the particular group of symptoms under his observation, or a group closely resembling it, may possibly originate. We had occasion in the article Medicine, in adverting to the attempts which have recently been made to undervalue the study of symptoms as compared with that of proximate causes, to point out the necessary connections and dependencies of these two subjects of medical inquiry; and to show that as, on the one hand, a more accurate observation of symptoms leads to greater precision in establishing the proximate causes of diseases, so, on the other hand, a more correct acquaintance with proximate causes leads to the more accurate noting and the more due appreciation of symptoms. But in considering the relations of symptoms and proximate causes, it is necessary to keep in remembrance, that there is a wide diversity in the degree of directness with which different symptoms indicate the morbid condition upon which they ultimately depend. Thus, if the lining membrane of the air-passages be inflamed, or, in other words, if a person be affected with catarrh, or bronchial inflammation, amongst the principal symptoms that will arise will be fever, cough, and expectoration. Now the *fever* is immediately an affection of the nervous and circulatory systems, liable to occur in a great variety of diseases besides bronchial inflammation. Its occurrence, therefore, warns us of derangement in some part of the economy, but does not lead us to the respiratory organs as the primary seat of this derangement. The *cough* depends on a preternatural action of certain of the respiratory muscles, and is liable to be excited by a number of different causes capable of calling these muscles into play. It serves in some degree, therefore, to guide us to the primary seat of disease. The altered secretion, again, of which the *expectoration* consists, is the immediate result of that state of inflammation of the lining membrane of the air-passages, which constitutes the proximate cause of the disease, and serves very materially to guide us to a knowledge both of its locality and of its nature.

In attempting to ascertain, from a consideration of the symptoms that present themselves, what the disease is with which his patient is affected, the conduct of the practitioner will vary according to the more or less inquisitive character of his mind. The empirical practitioner will content himself with endeavouring to determine what name the particular group of morbid phenomena or symptoms under his observation bears in systems of nosology; whilst the rational practitioner will aim at forming a judgment, from the consideration of these symptoms, as to the nature of the disease, or, in other words, as to the proximate cause on which it depends, and its immediate seat. Thus, if a patient presents the symptoms of yellowness of the skin and of the conjunctiva of the eye, the alvine evacuations being whitish or clay-coloured, and the urinary of a yellowish red or saffron hue, the empirical practitioner will be satisfied with knowing that he has to do with a case of jaundice, as distinguished from all other *nosological diseases;* whilst the rational practitioner or dogmatist will push his inquiries with the view of determining, if possible, whether the jaundice, in this particular case, is referrible to some morbid alteration of the structure of the liver itself, to the presence of gall-stones in the gall-ducts, or to the existence of spasm in these canals (morbid conditions or *pathological diseases* which may all separately or conjointly produce the symptoms that have been enumerated), or, in short, with the view of ascertaining what particular form of jaundice he has to subject to treatment. Both these practitioners must depend upon their observation of the symptoms that present themselves, for attaining the knowledge which they respectively desire. But the rational practitioner, whose object it is to arrive at a knowledge of the particular form of jaundice under consideration, must investigate these symptoms more accurately and minutely than is requisite for him who is content with the general knowledge of the fact, that the disease with which his patient is affected is that which has been termed jaundice. In the investigation of the rationalist, it is obvious, the differences between the objects to be distinguished, viz. the different forms of jaundice, are less apparent, the resemblances of these objects are closer, and their analogies are more striking, than those that exist between the objects of the empiric's comparison, viz. jaundice and other nosological diseases; and, consequently, a nicer and more elaborate analysis is required for their discrimination.

The process of analysis which the scientific medical practitioner has to carry on in his own mind, in endeavouring, from a consideration of the combinations of morbid phenomena or symptoms that present themselves to his observation, to arrive at a knowledge of the nosological disease with which his patient is affected, and of the morbid condition of the economy on which, in the particular instance, this nosological disease may depend, consists of several successive steps. 1*st,* He has to inquire what is the function, or what are the functions, a morbid affection or derangement of which is indicated by the symptoms observable. 2*d,* What is the particular process, or what are the particular processes, in the deranged function or functions, that are more immediately indicated as being disturbed. 3*d,* If several functions be deranged, he has to consider whether these derangements ought to be regarded as separate and independent occurrences, or as being dependent on one another; and if the latter, what is the particular relation subsisting between them in respect of antecedence and consequence. 4*th,* By these considerations respecting the deranged functions, the practitioner is gradually led to determine in his own mind what is the organ or part of an organ that is primarily and principally affected. And, 5*th,* having formed his judgment as to what is the organ, part of an organ, or texture affected, he has to consider the manner in which it is affected, or, in other words, what is the nature of its morbid condition; whether the symptoms can be supposed to depend on simple dynamical derangement, or whether they imply the existence of organic alteration of structure (see article PATHOLOGY); and also, what is the particular morbid change in property or in structure that must be supposed to exist. Under this last head is obviously comprehended the determination of the pathological nature of the disease with which the practitioner has to contend,—the consideration upon which the practice he is to pursue must necessarily be founded.

In each of the steps of this analytic process there is, in respect of a large number of diseases, ample room for mistake, not only in consequence of ignorance on the part of the practitioner, but in consequence also of the defective state of medical knowledge depending on the inherent difficulties of the subjects to which it relates. In whatever stage of the analytic process such mistakes may originate, their ultimate effect must be to lead the practitioner into one or other of two errors; 1*st,* that of supposing the existence of morbid conditions which do not actually exist; or, 2*d,* that of overlooking the presence of morbid conditions which do exist.

Sources of difficulty and fallacy in diagnosis.

We shall endeavour, in the following article, to point out, and to illustrate by particular examples, some of the circumstances under which the practitioner is liable to commit such mistakes; or, in other words, in which difficulties and fallacies in diagnosis are liable to arise. Our illustrations shall be drawn chiefly from the writings of some of the most eminent clinical physicians of the present day, in order to obviate any suspicion that the difficulties to which we refer are attributable to the want, on the part of the observer, of an acquaintance with those precepts which the present state of medical science furnishes for the discrimination of diseases from one another, or of skill in applying these precepts to particular examples. In the course of these illustrations it will appear, that not only may the several sources of difficulty and fallacy to be noticed exist separately, but that two or more of them may, in some instances, occur in combination, rendering the determination of the pathological condition or conditions existing in the economy a matter of proportionally greater difficulty.

I. Morbid lesions without symptoms.

The first circumstance to which we shall advert is the occasional existence of organic or structural pathological conditions in some of the textures, systems, or organs of the body, without this being indicated by any obvious or characteristic symptom, so that the physician remains entirely ignorant of their existence till it is revealed by examination after death.

Every part of the body, it may be presumed, is destined for the accomplishment of some particular end; and, reciprocally, each phenomenon which the economy exhibits is referrible to the operation of some particular part of the organized frame. It seems natural, therefore, to infer, that a deviation from the healthy structure of any part of the body must produce a determinate and perceptible change in the performance of the corresponding function; and, on the other hand, that where there occurs a deviation from the healthy performance of any of the functions of the economy, this must depend on some change having occurred in the structure of a corresponding part of the body;—in short, that where there is altered function, there must be corresponding alteration of structure; and where there is altered structure, there must be corresponding alteration of function. As general principles, these propositions are unquestionably true; but at the same time they are liable to very numerous and important exceptions. It has elsewhere been shown (PATHOLOGY, GENERAL) that very obvious deviations from the healthy exercise of the function of a part may manifest themselves during life, without its being possible to detect in that part, after death, the minutest deviation from its natural structure. And it is not less fully established, that in a large number of cases there have been found, on the dissection of bodies after death, deviations of parts from their healthy structure, of which no indicatory symptoms, direct or indirect, had presented themselves during life.

“ There is no anatomist,” as was remarked by Dr Thomas Simson, formerly the distinguished professor of medicine at St Andrews, “ who has had opportunity of opening any number of persons carried off without a manifest disease, but who must have had convincing proofs that there are great numbers of preternatural appearances in the body, which, during life, give no sensible disturbances.” (Edin. Med. Ess. and Observ. vol. v. p. 616.) “ It has been observed,” remarks another intelligent author (Dr Crampton, Trans. of the Assoc. Phys. in Ireland, vol. i. p. 1), “ by those physicians who are most in the habit of opening bodies, that they sometimes find morbid appearances after death, which they had not expected, even though they had closely attended to the antecedent symptoms.”

From the exercise of the function not being conspicuous.

From its purpose being unknown.

The circumstances upon which it may depend that a part of the body may be altered in its structure, and yet no deviation from its healthy functions, or from those of the economy generally, be observable, or at least be observed to result from this alteration, are very various. *First,* The exercise of the function of the particular organ may not be conspicuous to observation. *Secondly,* We may be ignorant of the purpose which the part serves in the economy, and consequently unable to detect any deviation from the proper exercise of its functions. It seems reasonable to expect that symptoms will be the more readily perceived, and the more characteristic when perceived, in proportion as we are well acquainted with the healthy functions of the organs on a morbid condition of which they depend, and can easily discern the exercise of these functions. And as the functions of those organs, and their several parts, are in general most apparent and best known, which either perform some of the vital motions (that is, of those motions without which life cannot be carried on for more than a very minute space of time), or which furnish some sensible secretions or excretions, so the symptoms resulting from diseased states of such organs must be more easy of detection, and more characteristic, than those symptoms that are connected with organs not similarly circumstanced. Thus, if the organs of respiration are out of order, or if the action of the heart, the spring of the circulation, is disturbed, the symptoms arising from such disorders are more readily perceived, and more easily referred to the organs concerned in their production, than are the symptoms that arise from the diseases of other parts the action of which is not so immediately necessary to life. If the secreting or excreting organs, as the liver or kidneys, fail in their proper offices, the symptoms thence arising are much more evident than those which depend on the derangement of organs that do not secrete any fluid from the blood; and among the organs that secrete a fluid, there will be greater facility in recognising the symptoms connected with those organs the fluid secreted by which is discharged out of the body, than with those organs whose fluid is retained in the body for the performance of some particular purpose; greater facility in recognising the symptoms produced by pathological conditions of the liver or of the kidneys, for example, than in recognising those produced by pathological conditions of the pancreas, though that, too, is a secreting organ, and separates from the blood a large quantity of fluid.[1] Dr Monro, in his enumeration of the circumstances which concur in rendering the history of diseases imperfect, has very properly included “ the imperfect knowledge we possess of the functions of some of the organs of the body. Thus,” adds he, “ we do not know whether or not the spleen be diseased, unless it has attained so great a bulk as to be felt by an external examination.” (Morbid Anatomy of the Gullet, &c. 1811, Introduction, p. xxx.) “ Nullum est viscus in corpore,” says Grottanelli, in a work expressly treating of diseases of the spleen (*Splenis Morbi,* p. 78, Florentiæ, 1821, 8vo), “ quod diutius subdole ægrotet, pathologicumque statum, absque manifesto detrimento servet, quam lien.”

From not be essent to life

Thirdly, The function of the organ may not be essential for the general wellbeing of the economy, as is the case with the ovary; or it may be of trivial importance in itself, and exercise little influence on the action of other organs, as is the case with the gall-bladder. “ Before there be any direct evidence of the existence of enlargement of the ovary, it has generally,” says Dr Hamilton, “ made a certain progress; and although there may be some data, from the appearances in dead bodies, for conjecturing the phenomena of the early stages of the disease, yet, practically speaking, a considerable advance must always have taken place before either the patient or the practitioner can be aware of its existence.” (Pract. Observat. on Subjects relating to Midwifery, part i. p. 71.) “ The gall-bladder,” says M. Andral, “ may be filled with calculi, and even with pus; its parietes may be the seat of different alterations; its cavity may have diminished in a considerable degree, or even disappeared; lastly, it may cease to receive bile, in consequence of the obliteration of the cystic duct, without there resulting during life, from any of these lesions, the production of any morbid phenomenon which can lead to a suspicion of their existence.” (*Clinique Médicale,* tome iv. p. 492.)

From contin notwit standin the org lesion.

Fourthly, The change which the organ has undergone, though apparently considerable in amount, may not be of a nature to prevent its performing its destined purposes in the economy. This seems in particular to be the case when the structural change occurs in a gradual manner, the parts apparently adapting themselves to their altered circumstances. “ When a compressing cause,” observes M. Cruveilhier, “ acts slowly on the brain, this organ accustoms itself to the compression, or rather the compressed portion becomes atrophied; and if this compressed or atrophied portion is not indispensable to the free exercise either of the sensory and locomotory functions, or of the intellectual faculties, the patient and the physician are not made aware, by any morbid feeling or phenomenon, of the existence of the cerebral lesion.” (*Anatomie Pathologique,* folio, livr. viii. pl. i. ii. and iii.) “ The very great frequency,” says Dr Sims, “ of collections of serous fluid found in the ventricles or membranes of the brain, in cases where no cerebral symptoms were known to have existed, is a subject of great importance to pathologists and practical physicians, especially when viewed in reference to the discrimination and curative treatment of apoplexy and other diseases of the nervous system. There is also a great variety of other morbid appearances found on dissection of the brain, in cases where no symptoms, or no symptoms adequate to explain the phenomena (that is, indicative of organic lesion of this organ), were noticed during life.”[2] “ Cerebral diseases,” says M. Rostan (Med. Clin. ii. 354), “ may go on without there existing any symptoms to characterize them. At all times the occurrence of latent diseases has been acknowledged; there exist fewer of them at present than formerly; our means of investigation have been multiplied to such a degree, that many diseases which would formerly have been overlooked, are in our days easily recognised. Nevertheless there are still affections of organs which we are surprised to meet with after death, and which have not produced during life any sign that could have revealed their existence. This point of pathology is truly very obscure, and almost inexplicable. It is very certain that these things happen when the affection has advanced slowly, and has destroyed the organ slowly; it is very certain also that a lesion of very limited extent, that has come on rapidly, gives rise to well-marked phenomena: but this does not alter the fact that, in the first case, an organ which is destroyed continues its functions; and that, in the second, an organ almost unchanged ceases from its functions. How can the functions still go on in the first case? how do they stop in the second? It is therefore very difficult, not to say impossible, to recognise diseases when they are truly latent; and that there are such, is proved by experience."

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[1] See Introduction to A Treatise on Biliary Concretions, by Thomas Coe, M. D. 8vo. Lond. 1757.

[2] With the view of attempting to illustrate this subject, Dr Sims has subjoined a table, containing fifty cases of persons who died of various diseases not cerebral, and who manifested no symptoms referrible to the brain, though, on dissection, effusion of fluid and other morbid appearances were found in the brain or membranes. Med. Chir. Trans. xix. 274–5.

The secreting glands seem to be capable of undergoing a very great degree of organic change without their secretion being put a stop to, or even sensibly disturbed, so that unless some other symptoms should happen to indicate the affection that exists, it will not be manifested by any deficient exercise of the proper function of the organ. M. Chardel, in his valuable Monograph on Scirrhous Degenerations of the Stomach (Paris, 1808, p. 133), observes, "that the examination of a great number of dead bodies has convinced him, that frequently even the most considerable diseases of the liver occasion no impediment to the secretion of bile. Very large tumours may form in this organ, appearing to occupy the greatest part of its parenchyma, and still the secretion continue." And he particularly refers to a case of hydatid of monstrous size that had formed for itself a cavity in the liver, without the biliary secretion being put a stop to.

The urinary organs furnish us with numerous illustrations of the existence of organic affections, very considerable in their apparent degree, of which in many instances no indicatory symptoms manifest themselves during life, or at least during a considerable period of their existence. There is perhaps no organ of the body in which a greater extent of structural alteration may take place, without affecting, in a very marked degree, the exercise of its function, than the kidney. In some cases the urine has continued to be secreted when, from the progress of a particular form of disease, little more than the mere shells of the two kidneys has seemed to remain. (See Chardel, as above.) In other cases, calculi in considerable number, and of considerable dimensions, exist in the kidney without materially deranging their function, or otherwise betraying their own existence. "So long," says M. Chopart (*Malad. des Voies Urinaires*, i. 179), "as calculi remain concealed in the kidneys, they give no sensible signs of their presence. They may exist there and increase, without producing uneasiness, and without causing any symptoms that can even excite a suspicion of their existence. We have quoted examples of persons whose kidneys contained calculi which had not occasioned any pain to them. Baglivi found large calculi in the kidneys of two persons who, during life, had never complained in these viscera." To the same effect a more recent writer, Dr Marcet, in mentioning the symptoms with which calculus lodged in the kidney is generally accompanied, adds, "Yet cases of this kind occur in which these symptoms are scarcely perceptible; it will appear hardly credible, for instance, that the patient from whom the kidney represented in plate i. was taken, died of hydrothorax, at Guy's Hospital, without any symptom having occurred which could lead me to suppose that there was any disease in the urinary organs." (Essay on Calculous Disorders, 2d edit. p. 11.) In the case alluded to, the pelvis of the kidney was much enlarged and distended by a number of calculi closely pressed against each other; and other calculi were contained in the enlarged infundibula.

In the bladder, also, there may, under particular circumstances, exist disease to a considerable extent, without any indication of its existence being furnished by the attendant symptoms. "In several cases," says Sir Everard Home (Diseases of the Prostate Gland, ii. 239), "in which I have examined the body after death, calculi have been found enclosed in cysts formed between the fasciculi of the muscular coat of the bladder, so as to be entirely excluded from the general cavity, and therefore had not produced any of the common symptoms of stone. I have seen in the same bladder two, three, and even four such cysts, each containing a calculus of the size of a walnut." And, even independently of the existence of such cysts, calculi may, as Mr Wilson has remarked, "exist in the bladder for years, without producing always those distressing symptoms which render life a burden, and which so frequently occur in this disease." (Lectures on the Urinary Organs, &c. p. 238, 1821.)

From its being executed by another organ.

Fifth, Some other organ or part may supply the place of that which, by a change of structure, has, in whole or in part, been rendered incapable of exercising its function. This is especially the case with those glandular organs which are double; for when one of these is morbidly affected, the other not unfrequently performs its function in such a manner as to supply the place of both. "Suppression of urine," says Mr Howship (Complaints that affect the Secretion and Excretion of the Urine, p. 2), "may be complete or incomplete. The first case is very rare; the second comparatively frequent. An affection that either deranges or destroys the functions of one kidney, may leave the other to the more vigorous performance of its duty; a circumstance most happily calculated to guard the constitution from the ill effects of a disease the complete establishment of which is almost invariably fatal." "What we have said," remarks M. Bouillaud, "of the obscurity of the signs of diseases of the kidneys, is applicable to those of the lesions of the ureters. If these two canals were obliterated simultaneously, fatal consequences would ensue; but this does not happen when one of these organs only is obliterated. From a case which I shall relate, it appears that, in some instances of this kind, the kidney which has its ureter obliterated, has a tendency to become atrophied, whilst the other becomes hypertrophied, as if that it may be able of itself to fulfil the function which it formerly divided with that of the opposite side. I do not affirm, however, that this is in all instances the case." (*Journ. Compl.* xxxi. 15.)

May we, in this point of view, consider the brain or any portion of it as a double organ; that is to say, may we believe that the corresponding portions of its two hemispheres co-operate in the exercise of a common function, and that this function will continue to be performed without any sensible or considerable impairment, though the part concerned in its exercise is injured or diseased on one side, provided the corresponding part of the opposite hemisphere remains sound? M. Bouillaud (*Traité de l'Encephalite*, p. 263, 1825), in speaking of the lesions of the intellectual functions which occur in encephalitis, or inflammation of the brain, decidedly adopts this idea, "When one of the hemispheres only is diseased, either in whole or in part, the phenomena purely intellectual continue entire. I have adduced a great number of observations in support of this fact. The slightest reflection, indeed, might have enabled us to anticipate this result. It is obvious that the brain, the organ of the intellectual faculties, being composed of two halves, which are symmetrical and perfectly similar, each of them is equivalent, in what regards the mechanism of intelligence, to the two combined." And M. Lallemand had previously expressed his belief (*Rech. Anat. Pathol. sur l'Encephale*, 1820, i. 435), "that when the sound hemisphere of the brain is not compressed by the one which is diseased, it will continue to perform its functions in respect of intelligence, as in respect of voluntary motion and sensibility; that the patient will continue to think with a half of his brain, as he continues to see with one eye, and to hear with one ear."

Sometimes one organ may supply, in a mechanical manner, a deficiency or imperfection in its neighbour; and in such a case the existence of the deficiency or imperfection may not be indicated by any apparent disturbance of the action of the organ in which it exists. This happens by no means unfrequently, for example, when an aperture in the stomach, produced by chronic ulceration, is filled up by the adhesion of the liver, the pancreas, or the spleen, to the margins of the ulcer. "I have been often surprised," remarks Dr Pemberton (On the Abdominal Viscera, 3d edit. London, 1814, p. 130), "to find very extensive mischief in the structure of the stomach, without the constitution being sensibly affected by it; that is, provided the mischief was so situated as not to interrupt the passage of the food. I have seen a large scirrhus in the stomach, near the pylorus, with an open cancer in one part of it, which had made its way through the stomach and through the left lobe of the liver, and an adhesion had taken place between the sides of the abscess and the peritoneum; so that, had not the patient been taken off by a disease in the aorta, I have no doubt but that this abscess would have made its way out through the integuments of the abdomen. Still, however, though this must have been a disease of very long standing, the body was but little emaciated, and the patient had never shown any one symptom by which such a disease of the stomach could possibly have been suspected. This single case," adds Dr Pemberton, "is sufficient to point out the infinite difficulty there is to determine the nature of internal diseases."

From unknown reasons.

Sixth and *lastly*, Medical men must confess that, in some instances, they are unable to assign any plausible reason why the diseased organ does not reveal itself by any outward indication of deranged exercise of function. Thus M. Andral has related (*Malad. de l'Encephale*, p. 402, 403) some cases in which morbid softening of the brain, variable in its extent and in its seat, produced neither pain of the head nor disorder of the intellect, nor alteration of motion, nor disturbance of the sensations; nothing, in short, occurred during life that could even excite a suspicion of the central part of the nervous system being in any way affected. "As in these cases," remarks this accurate observer, "the softening was seated in different parts of the hemispheres of the brain, the absence of symptoms cannot be explained by the particular *seat* of the alteration. As to the *nature* of the alteration, it appeared identical in all the cases. In all, certainly, the softening was uncomplicated with any injection, effusion of blood, or other lesion; but its latency could not reasonably be attributed to this circumstance. Shall we explain it by *conditions inherent in the individuals themselves?* Shall we remark that they were all exhausted by chronic diseases, which must have blunted the sympathies, and diminished the tendency to re-action? But in many other cases we shall find the existence of the same chronic diseases not in any degree preventing the development of the usual symptoms of softening of the brain. Lastly, shall we refer the circumstance to the advanced *age* of the persons? This reason would not be more available than the others; for, though one of the patients was an octogenarian, another was only forty-five years of age. Let us here acknowledge, then, our complete ignorance; and, in reference to these facts, to which we find analogous ones in respect of each lesion that occurs, let us recall to mind a principle which cannot be too often repeated, viz. that the alterations of texture which an organ has undergone do not necessarily occasion a derangement of its functions. Thus there are organic lesions without symptoms, as there are symptoms without any appreciable lesion that can account for them."

To those who are engaged in the examination of dead bodies with a view to trace the connection between the symptoms of diseases and the morbid alterations of structure that produce or accompany them, it must obviously be of essential importance to distinguish, in particular cases, those alterations of structure that had existed during life, without giving any outward indication of their existence, from those on which the symptoms that manifested themselves really depended. The observation of some cases in which the coronary arteries of the heart (the vessels by which the substance of this organ is supplied with blood) were found after death to be ossified, in persons who during life had exhibited the symptoms of the painful affection of the chest termed *angina pectoris*, led some practitioners to conclude that they had detected, in that alteration of structure, the proximate cause of this disease. More extensive observation, however, has shown that ossification of the coronary arteries often exists without the symptoms of *angina pectoris*, or even without any symptoms whatsoever, manifesting themselves; as it has also shown that the symptoms of *angina pectoris* may occur in persons whose coronary arteries are sound. In the same way some recent pathologists have endeavoured to establish that asthma depends, in all instances, upon organic disease of the heart; though it seems to be well established, by the researches of accurate observers, that, though asthmatic symptoms and structural affection of the heart are frequently conjoined, every form of organic alteration may exist in the heart without inducing the symptoms of an asthmatic paroxysm; and that in many persons liable to such paroxysms, there exists no alteration in the structure of the heart. "One who would investigate diseases among the dead," as was remarked by an author formerly referred to (Dr Thomas Simson, in the Edin. Med. Ess. and Observ. vol. v. p. 617), "should have a large history before him of what the living can bear without disturbance. If this had been always the qualifications of our dissectors, in what different light should our histories of diseased bodies appear. And, in consequence of this, physicians should not have been so far misled in advancing the causes of diseases, and of the death of their patients, as to have placed every irregularity found as the original of the symptoms they had observed in life. A cautious theorist can never be satisfied in his inquiries till he has found out the disorder whence he can deduce all the symptoms that had appeared to him, by easy and natural consequences. A disorder that he observes upon dissection that has no apparent connection with the apparent disorder that happened in the actions of his patient, must be passed by him as foreign to his inquiry, or is only to be left on record to see if others may afterwards find the connection; but till then, such a disorder can never justly be advanced as the cause of any particular disease."

After the preceding view of the circumstances under which an organic or structural morbid affection of some part or other of the body may escape detection, in consequence of its not giving rise to any perceptible alterations in the exercise of the functions of the economy generally, and more particularly of the functions of the part in which it is situated, we come next to consider those sources of difficulty and fallacy in diagnosis, from which it arises, that although morbid phenomena or symptoms do manifest themselves, it is under circumstances calculated to create an uncertainty as to the nature and seat of the pathological condition on which they depend, or even to excite a belief in the existence of morbid conditions very different from those that actually exist.

In the first place, then, groups or trains of symptoms arising from different pathological conditions, may be identical, or at least so similar as to render their discrimination exceedingly difficult, if not impossible. In some cases, this similarity or identity in the groups of symptoms produced by different pathological conditions, is constant, so that the well-informed practitioner is on his guard against the risk of mistake. But, in other instances, a pathological condition usually recognisable by a group or train of symptoms peculiar to itself, assumes appearances foreign to its own habitual or ordinary character, and such as usually accompany some other form of morbid condition, so that the practitioner is taken, as it were, unawares, and exceedingly liable to adopt an erroneous opinion as to the nature of the disease which he is proceeding to treat. From the illustrations to be quoted, it will be seen that when different pathological conditions or proximate causes give rise to the same group or train of symptoms in different persons, they may have their seat in the same organ, or in different organs. In either case it may be that both the morbid conditions are of an organic character, or that the one is organic and the other dynamical.

We shall, in the first place, adduce some examples of organic pathological conditions, differing in nature, but corresponding in seat, which give rise to groups or trains of symptoms so similar, as to render it difficult, if not impossible, to say, during life, with what morbid condition the patient is actually affected. M. Andral, after describing the different morbid alterations of the mucous membrane of the stomach, and of the subjacent textures, that may arise from chronic inflammation (including cancer, according to the view which he takes of the nature of this disease), puts the question, whether the infinitely varied lesions which he has described are each of them marked by a peculiar train of symptoms? "We do not fear," says he, "to answer in the negative. With the exception of some symptoms that are the mechanical result of the obliteration of the cardia or of the pylorus (the two apertures of the stomach) by a tumour, the same phenomena most generally attend during life these so different alterations of form and of structure." (*Malad. de l'Abdomen*, p. 429.) In speaking of the symptoms of diseases of the liver, the same author says, "they are few in number, often too obscure or too little marked to enable us from a consideration of them always to affirm the existence of an affection of the liver. In other circumstances there is no room for doubt as to the existence of an affection of this organ; but it is very difficult, or even impossible, to determine its nature. For, on the one hand, analogous symptoms are often produced by affections of the liver which present the greatest differences in respect of their anatomical characters; and, on the other hand, we cannot say that in any of these affections we find any particular symptom constantly present." The same principle is applicable to the diseases of the urinary organs. Dr Marcet, after enumerating the symptoms generally produced by calculi in the kidneys, or by their passage into the bladder, adds (lib. cit. p. 13), "yet the occurrence of these symptoms cannot be considered as an absolute demonstration of the existence of this disease, unless calculi have been actually discharged; since it is well ascertained that symptoms very nearly similar are also sometimes occasioned by mere inflammation of the kidneys, without any concretion being present."

Before pointing out examples of an organic and a dynamical pathological condition of the same organ producing similar or identical groups or trains of symptoms, it may not be amiss to suggest of how much importance it is that the physician should be able to ascertain whether the proximate cause on which the symptoms in a particular case of disease depend, is organic or dynamical, since, according to the conclusion he may form on this point, the general plan and objects of treatment must be very materially influenced. It is in the class of dynamical diseases chiefly that the efforts of the medical art are likely to be of avail. Of organic diseases there is a very large portion in which, though we may for a time retard their progress, or alleviate the sufferings to which they give rise, we can entertain very little or no rational expectation of effecting a cure. The distinction between an organic and a dynamical disease of the same organ is one, however, which, in practice, it is very far from being at all times easy to make. The existence of an organic disease can, indeed, frequently be ascertained by direct observation, or by what may be called its physical indications or signs, as when it is seated in external parts, or in parts which the practitioner is able to examine by sight or by touch, directly or with the aid of instruments. In this mode of investigation a correct knowledge of the geography of the body, if we may so speak, is obviously essentially necessary. The practitioner must know the ordinary position of each part, its extent and its relations to the other parts in its neighbourhood. He must know in what situations to expect a prominence, and in what a depression; where to expect to find a soft and yielding part, and where a part that is hard and resisting. But even where he is able by direct observation to ascertain the existence of an organic disease, he often derives from this no knowledge of its particular nature, no information, for example, as to whether a tumour is simply inflammatory or scrofulous, whether it is of a mild or of a malignant nature; nor consequently does he obtain any insight into its probable progress: and in a great many of the organic alterations which occur, from the deep and remote situation of the parts which they occupy, as in diseases of the brain, for example, he is not apprized by direct observation, even of their existence. For all that remains to be learned respecting organic diseases, their existence, their nature, and their seat, after the means of investigation deducible from direct observation, or from what we have called their *physical* indications or signs, have been exhausted, the practitioner must, as for the whole of his knowledge of dynamical diseases, be entirely dependent on the detection of deviations from the regular exercise or performance of the several functions of the body, or of what may be termed the *functional* indications or signs of diseases. Hence it is obvious of how great importance an accurate knowledge, both of the healthy phenomena of the economy (as embraced in the science of physiology), and of the various modifications which these phenomena are liable to undergo in the state of disease (the branch of general pathology termed Symptomatology, or Semeiotics), must be to the practitioner of physic.

We may now point out some examples of an organic and a dynamical disease of the same organ, producing groups or trains of symptoms apparently identical. In diseases of the brain, the same train of symptoms may arise from an obvious organic alteration, or without any such alteration, and, as it is usually expressed, from mere functional disturbance. "A person previously in perfect health," observes Dr Abercrombie (On Diseases of the Brain, 3d edition, p. 199, 200), "falls down suddenly, deprived of sense and motion, and dies after lying for some time in a state of coma. We find, on examination, a large coagulum of blood compressing the surface of the brain, or filling its ventricles, and the phenomena of the disease appear to be distinctly accounted for. Another person is cut off with the same symptoms, but nothing is met with except serous effusion in no great quantity in the ventricles, or only on the surface of the brain. A third is seized in the same manner, and dies after lying for a considerable time in a state of coma, from which nothing can rouse him for an instant; and, on the most careful examination, we cannot detect in his brain the smallest deviation from the healthy structure." Here, then, are three cases which, as presenting the same external phenomena, all fall under the same nosological disease, apoplexy; but of which the first may be regarded as depending on an organic, and the last, at least, on a dynamical affection; whilst with regard to the second, it may not be easy to determine whether the morbid appearances discovered after death should be regarded as the primary disease, or only as one of its effects.

The stomach may be mentioned as another organ the structural and dynamical affections of which give rise to closely resembling groups or trains of symptoms. "To trace exactly the phenomena of a disease," says M. Chardel (lib. cit. p. 159), "is not always sufficient for conveying a proper knowledge of it; it is still necessary to point out any other affections the resemblance of which with the object of our researches might possibly occasion mistake. This observation is of especial importance in the case of incurable diseases, since, to confound these with other diseases that are susceptible of cure, is to deprive the unfortunate persons committed to our charge of the assistance which they had a right to expect, and to deceive their confidence. No affection," this author proceeds to observe, "simulates so completely scirrhous degenerations of the stomach as spasmodic vomiting, or that arising from an immediate lesion of the principle of life in the nerves of the stomach, from a special sensibility of that viscus."

Of different organs,

In other instances in which different pathological conditions or proximate causes give rise to the same group or train of symptoms in different individuals, the different lesions have their seats in different organs or parts of the body. These organs or parts may be related to one another simply in the way of contiguity or superposition; or there may exist some functional dependence or sympathetic connection between them.

related by proximity;

The mistakes liable to occur in the judgments of medical men as to the existence or non-existence of aneurism, furnish an illustration of the similarity that may exist in the morbid phenomena induced by different pathological conditions of organs or parts in near proximity. "The occurrence of a pulsating tumour in the vicinity of an artery," says Mr Hodgson (Diseases of Arteries and Veins, p. 88), "will induce every cautious surgeon to suspect the existence of an aneurism. But there are many diseases which, from their situation, or from other circumstances, may assume the symptoms of aneurisms; and in some instances aneurisms assume the appearances of other diseases." "The circumstances that characterize the existence of an aneurism are much more complicated when the disease is situated in the thorax or abdomen, than when it exists in the extremities. Aneurisms in the thorax or abdomen frequently prove fatal before a knowledge of their existence is confirmed by that evidence which the appearance of the tumour externally generally affords; and the viscera with which they are surrounded are subject to a variety of diseases, many of the symptoms of which are common also to aneurisms of the aorta and of its primary ramifications."

If we turn our attention to the diseases of particular organs, we shall find ample illustrations of the source of fallacy in diagnosis to which we have just alluded. Practitioners are well aware that a difficulty of breathing or of swallowing may arise not only from affections of the organs by which these functions are respectively exercised, but from morbid conditions of one or other of the neighbouring organs or parts, as of the thyroid or bronchial glands, the vertebræ, and the larger blood-vessels; and also, that whilst difficult respiration may be occasioned by morbid conditions of the pharynx and œsophagus (the organs by which deglutition is effected), difficulty of deglutition may arise from morbid conditions of the glottis, of the larynx and trachea, and even of the lungs, that is to say, of the organs of respiration. "Aneurisms arising from the thoracic aorta," Mr Hodgson has remarked, "by compressing the trachea and œsophagus, produce great impediments to respiration and deglutition, and are often mistaken for diseases of the lungs, or strictures of the œsophagus." (P. 91.) M. Cruveilhier, in speaking of the diagnosis of inflammation of the larynx, remarks, that "a very serious error, and, at the same time, one very easily committed, is the referring to inflammation of the submucous membrane of this organ the effects of the compression of the trachea by an aneurism of the arch of the aorta. Nothing resembles more a paroxysm of suffocation produced by laryngitis than the dyspnœa occasioned by the pressure of an aneurismatic aorta upon the windpipe. I have myself," he adds, "been on the point of committing this error so much the more easily that the individual submitted to my observation was at the same time affected with hoarseness of the voice." (*Dict. de Méd. et Chirurgie*, xi. 35.)[1]

"As to the symptoms of splenitis," says M. Andral, "their great obscurity depends on several causes; for, 1*st*, as the functions of the spleen are unknown, their disturbance cannot reveal its morbid condition in the same way as the disturbance of digestion reveals an affection of the stomach; and, 2*dly*, the symptoms produced by inflammation of the spleen must be easily confounded with those arising from inflammation in one of the surrounding organs, and *vice versa*." (*Diction. de Médecine*, art. SPLENITE.) "The symptoms of the diseases of the pancreas," it has been remarked, "are obscure, being for the most part such as belong equally to morbid affections of other parts contained within the abdominal cavity. It is, indeed, very seldom that we are able to discover pancreatic disease in the living subject." (Dr Carter, art. PANCREAS, in the Cyclop. of Pract. Medic.) "From common experience," remarks another author, "and the evidence of morbid dissection, it may justly be inferred that disease of the pancreas is a rare occurrence; yet the difficulty of ascertaining the condition of this organ in the living subject, by any other symptoms than such as are secondarily manifest in the stomach or liver, must render our judgment in many cases uncertain, and our practice, doubtless, sometimes erroneous." (Dr Percival, Trans. Assoc. Phys. in Ireland, vol. ii. p. 128.)

We have seen, in respect of the kidneys, the difficulty of distinguishing, by the symptoms that manifest themselves, between the different affections of which these organs may be the seat. But besides this, they also afford proofs of the difficulty of distinguishing between the morbid conditions of a particular organ and those of the parts in its vicinity. "The diseases of parts near to the kidneys," says Chopart, in reference to the diagnosis of renal calculus (lib. cit. p. 182), "may be accompanied with symptoms closely resembling those which manifest themselves in calculous nephritis. Have there not been found, in persons believed to be nephritic, scirrhus, abscesses, and calculi of the pancreas, or of the mesentery; the spleen scirrhous, displaced and lying upon the kidney; a tumour of the intestines resting on that viscus, &c.? Other facts of the same nature might be adduced in confirmation of the difficulty that exists in judging of the presence of calculi in the kidneys. But if in some cases we cannot arrive at certainty, we may at least have strong presumptions respecting this disease, by combining all the symptoms, and comparing them with one another."

It is proper to be kept in mind, that the resemblance in the symptoms produced by morbid conditions of organs related to one another by proximity, may show itself either in physical or in functional indications. Of resemblance in physical indications, we may take an example from M. Chardel, who, in pointing out certain circumstances under which scirrhus of the stomach may exist without any tumour being perceptible in the epigastric region, suggests (lib. cit. p. 185) that, on the other hand, tumours really existing in some other organ, such as "a prominent liver, an abscess in the posterior cavity of the epiploa, or a swelling of the pancreas, may simulate an induration of the stomach. Tubercular mesenteric glands, when they are in the neighbourhood of the stomach, may easily be taken for a scirrhus of that viscus." And he adds, that "it is possible that the hardness which the muscles of the abdomen, particularly the recti, exhibit in persons in whom they are strong and much exercised, may equally lead into error." Of resemblance in functional indications, we may quote an instance mentioned by Mr Hodgson, who observes that "when an aneurism arises from the aorta at the root of the cœliac artery, it is attended with frequent sickness, more especially after food is taken into the stomach, and by its pressure produces symptoms like those of stricture of the pylorus." (P. 95.)

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[1] See generalization of the same fact by Dr Cheyne, in the article LARYNGITIS of the Cyclopædia of Practical Medicine; and corroborative cases in the Lond. Med. Gaz. i. 322, and the Edin. Med. Surg. Journ. xliii. 293, the latter by Professor Graham. See case of aneurism of the aorta, producing symptoms of pneumonia, related by Rostan, Médecine Clin. i. 64; and on the difficulty of diagnosis in internal aneurisms, particularly abdominal, see case by Dr T. E. Beatty, in Dubl. Hosp. Rep. v. 166.

The reciprocal influence which the different parts of the body exercise upon one another, often throws great difficulty in the way of the practitioner in attempting, in particular instances, to ascertain the seat of disease from a consideration of the symptoms that attend it, seeing that the prominent symptoms may point at organs very different from those which are actually the seat of disease. This influence is sometimes exerted between parts that co-operate in the performance of the same general function, as when vomiting arises in consequence of obstruction of some portion of the intestinal tube; but in other instances it is exerted between parts concerned in the performance of functions essentially distinct, as when headach or palpitation of the heart occur in various derangements of the stomach and bowels. In consequence of this reciprocal dependency of different parts, not merely may a symptom immediately referrible to some particular organ depend on an affection of an organ quite distinct from this, but the same symptom may arise from affections of several different and remote organs. Thus, for example, the symptom of cough, the immediate cause of which is known to be the convulsive or rapid contraction of certain respiratory muscles, may occur as a symptom of various affections of the air-passages or lungs; but it may also form a very prominent symptom in diseases having their seat in parts remote from the respiratory organs; and a late French author, M. de Larroque, has published a work professedly treating of cough as a symptom, more or less severe, of certain abdominal diseases. The circumstances just adverted to render it impossible, it may be remarked, to characterize and recognize diseases by one particular prominent symptom. It is only by marking and analysing the concomitant groups of symptoms that we can arrive at a knowledge of the organ which is the primary seat of disease. When a patient complains of headach, for example, the practitioner must judge, from a consideration of the other symptoms by which this uneasy feeling is accompanied, whether it depends on the existence of some pathological condition in the head, the immediate seat of the symptom, or in the organs of digestion, the derangements of which we know to be capable of inducing it sympathetically. In the same way, when the outstanding or prominent symptom is vomiting, it is only by a careful consideration of the concomitant circumstances that we can hope to determine whether it is in the stomach itself, or in some other organ more or less immediately connected with it, that the original seat of mischief is to be found.

"The general signs by which pericarditis may be recognised," says Mr Adams, "are exceedingly equivocal, and much requires to be done by the physician to clear the obscurity. I have been frequently called upon to examine the bodies of persons supposed to have died of disease of the lungs or liver, and I have found pericarditis the true and single source of death, although during the previous illness the heart was never suspected to be the seat of a fatal affection. I have myself been witness to the treatment of a case of chronic inflammation of the pericardium in a girl aged fourteen, which terminated fatally, and during the whole progress of the disease, phthisis, or rather what was considered hepatic phthisis, was the disease under which this child was supposed to be gradually declining." (Dubl. Hosp. Reports, iv. 360.)

Morbid conditions of the alimentary canal are peculiarly liable to produce disturbance in the functions of some other organs, without betraying their own existence. "Such," says M. Piorry, in an essay on the influences which the stomach exercises on other organs in health and in disease (*Journ. Complem. du Dict. des Scien. Méd.* xvi. 199), "such is frequently, in diseases of the stomach, the intensity to which the sympathetic lesion of the related organs amounts, that it seems to destroy the primary affection, or at least to cause it to be overlooked. Whilst the patient labouring under such disease experiences only slight uneasiness in the epigastrium, he is tormented by the severest and most intolerable cerebral, muscular, thoracic, and other pains." "The exact appreciation of the nature of the symptoms observed," remarks the same author, "is so much the more difficult on this account, that the organ whose sufferance is symptomatic of the lesion of another part becomes itself a new centre of irradiation, which induces, in its turn, secondary irritations or pains. And as there is nothing to prevent these from being, in their turns, new points of departure of physiological influences, there results excessive difficulty in establishing a just diagnosis, in cases so embarrassing." Every one is aware of the influence which the presence of worms in the intestines is generally believed to exercise in producing derangement in the functions of remote organs. "There are few diseases," says M. Andral (*Fievres*, p. 273–5), "particularly in children, of which worms have not been supposed to be capable of being the cause. Klein has said, 'Nullum tam peregrinum est symptoma, tamque δαιμονιακον, quod vermes excitare non possint.' We read in authors numerous examples of palsies, comatose attacks, asthmas, palpitations of the heart, obstinate coughs, epilepsies, and hysterical convulsions, depending on that cause. Even tetanus has been considered as the result of the presence of worms in the intestinal canal. In the time of Alexander Trallianus, it was said that, when worms passed from the small intestine into the stomach, they gave rise to excruciating cardialgia, to syncope, and that sometimes even they occasioned sudden death. It must be confessed, that observations of this kind become the less frequent as pathological anatomy is more generally and more carefully cultivated. But, in hesitating as to the reality of these extraordinary facts, let us be careful not to deny altogether their possibility. A hemiplegia caused by worms would not appear to us a less credible phenomenon than a palsy succeeding to the introduction of particles of lead into the alimentary passages. Now nothing, unfortunately, is more real and more common than this last species of palsy. The symptoms caused by worms may, besides, be expected to vary much according to their nature, their number, their greater or less mobility and activity of existence, their more or less immediate contact with the mucous membrane, their situation in particular parts of the alimentary canal, the energy of the patient's sympathies, his nervous susceptibility, &c. Amongst physicians, said De Haen, some have made worms play too important a part in the production of diseases; and others have not paid sufficient attention to them."

Lesions of nervous centres producing symptoms in remote organs.

To the class of cases in which different pathological conditions, having their seats in different organs or parts of the body, give rise to the same group or train of symptoms, may be referred those in which lesions of the central, or cerebro-spinal and ganglionic, portions of the nervous system occasion the development of symptoms in remote organs of the body, similar to those that are produced, or that may be supposed to be produced, in these organs, by morbid lesions of which they are themselves the immediate seats. In many cases, for instance, of local pains or neuralgias, as of neuralgia of the mamma, of the intercostal muscles, and of the arm, there is reason to believe that the pain is not attributable to an affection of the nerves of the parts to which it is referred, but (as Drs Brown, Darwall, Teale, and other authors, have pointed out) is caused by the presence of a primary diseased state in the spinal cord itself, or in its coverings. Although our limits do not allow us to enter fully into the illustration of the doctrine of spinal and ganglionic irritation, as it has been called, we cannot refrain from quoting a very graphic account of the diversity of symptoms manifested in this class of cases, which is given in a paper on diseases simulating acute inflammatory attacks of various important organs, by Mr Torbet, surgeon in Paisley, contained in the forty-fourth volume of the Edinburgh Med. Surg. Jour. p. 375. "Of the diseases in question," says that author, "females frequently before, sometimes after, puberty, are the most usual victims. The individuals are of what is called irritable constitution, a peculiarity moreover distinctly hereditary, and connected more or less with strumous diathesis. The morbid train of neuralgic symptoms is most usually set in operation either by a serious inflammatory or febrile disease, by excessive fatigue, or by injury, as from a heavy lift or severe fall. The severity and variety of diseases to which the individuals appear to be liable, might almost characterize the affection. You are astonished to hear of their violent illnesses, the powerful remedies that are applied, and the rapidity with which they shake off these attacks. In severity their diseases resemble those of no other persons. They are paralytic, blind, speechless, without food, and without sleep, for weeks or months, and yet they do not die. Is the head the organ affected? Then they have headach, of which no words can convey an idea, ending perhaps in insensibility; or there is a heavy weight pressing down their eyelids, a tight bandage compresses, or hammers beat within their heads, bells ring in their ears, vertigo and sickness overpower them, noise and light disturb them. Is the chest affected? Then a sepulchral cough, each fit of which seems to threaten existence, over which medical art seems to possess no control, harasses from morning to night, and night to morning. There is excruciating pain in the chest, especially during the cough, which is perfectly devoid of expectoration. There is a feeling of swelling and choking at the under part of the neck, tremendous palpitation of the heart; the pulse is quick and agitated, but varying greatly with the severity of the cough; and the heart's pulsations seem to occupy the whole left side of the chest. Is the digestive apparatus the seat of disease? Then ensue vomiting without apparent cause; incessant retching for hours, occurring perhaps every day for weeks, without any thing being vomited; no appetite; unquenchable thirst; occasional severe pain in the belly, or muscular cramps; and costiveness alternating with diarrhœa, the stools being unaccountably copious. Are the organs of voluntary motion attacked? Then there are cramps, prickling or numbness, sometimes severe spasms, liker tetanus or hydrophobia than any thing else, ending possibly in catalepsy; or paralysis of one or more limbs ensues. Such is an epitome of the symptoms of the more violent cases; but almost endless variety must of necessity occur, according as the several nervous centres are affected, and their affections modified by individual circumstances. It is precisely from this variety and anomaly of appearances that practical men are apt to be misled. The most marked symptoms are apparently so distant from, and unconnected with, nervous irritation, and are moreover so violent and similar in their character to pure inflammatory diseases, that there is great risk of our chief curative efforts being directed to the appendages and coincidents, instead of attacking the disease itself."

Lesio of nervo trunk p. ducin symp s at the branc

Numerous facts upon record show that a pathological condition existing in the trunk of a nerve may produce symptoms that appear referrible to the organ in which its branches are distributed. "Every part to which a nervous filament can be traced," as is remarked by Sir Benjamin Brodie (Lectures illustrative of certain Local Nervous Affections, p. 2), "may be said to have its corresponding point in the brain or spinal marrow; and an impression made either at its origin, or anywhere in the course of the trunk of a nerve, will produce effects which are rendered manifest where the nerve terminates, at that extremity of it which is most distant from the brain." The experiments of different physiologists had fully established, that when the pneumogastric nerve, or the recurrent branch of this nerve, which goes to the larynx, is divided on each side of the neck, paralysis of the muscles that open the glottis is produced, and, as a consequence of this, the state of stridulous breathing. The knowledge of this fact has been very ingeniously applied by the late Dr Hugh Ley to the explanation of certain affections of respiration occurring as consequences of disease. Thus he conceives that the crowing or croup-like inspiration which is not unfrequently met with in infants, depends primarily, not on a morbid state of the parts constituting the glottis itself, but upon a morbid condition of the pneumogastric and recurrent nerves; and that in very many instances it is connected with a diseased state of the lymphatic glands of the neck, producing pressure upon these nerves. He has endeavoured likewise to show, that the fits of dyspnœa and stridulous breathing, which patients affected with tumours, aneurisms, or other organic diseases at the root of the neck, sometimes experience, as well as the asphyxia by which such persons are not unfrequently cut off, are often attributable, not to any mere physical or organic compression upon the trachea or larger bronchi, but to the diseased masses being so situated as to cause compression, stretching, or more or less complete destruction, of the pneumogastric nerve, or its recurrent laryngeal branch. (On Laryngismus Stridulus.)

Lesio of remot r. gans ducin symp s in ne us centre

But whilst morbid conditions of the central parts of the nervous system frequently give rise to groups or trains of symptoms that seem referrible to distant organs, on the other hand it sometimes happens, as M. Lallemand has remarked, that diseases having their seat elsewhere than in the brain produce phenomena analogous to those occasioned by certain cerebral affections. (Preface, p. 20.) M. Andral relates (*Malad. de Poitr.* vol. ii. p. 444) a case in which the symptoms that manifested themselves during life were those of inflammation of the membranes of the brain, whilst the morbid appearances found after death were those of acute inflammation of the serous membrane of the heart; and he refers to a case related by M. Rostan, in which there occurred cerebral symptoms, for the explanation of which no other lesion was found than that of inflammation of the investing membrane of the heart. "These two cases," M. Andral remarks (p. 447), "are well calculated to show, that in consequence of individual susceptibilities, there is no organ the lesion of which may not induce the most varied nervous symptoms, so as to produce sympathetically the different morbid states (*i. e.* nosological diseases) of which we place the seat in the nervous centres and their dependencies. It has been correctly laid down, that the alimentary canal, when inflamed, re-acts, more frequently than any other organ, upon the brain, and gives rise to the symptoms of inflammation of the membranes or substance of the brain. But it is not less true, as M. Boisseau has already very well shown, that inflammations of other organs may equally produce, by their sympathetic influence on the encephalon, the different groups of symptoms which constitute the ataxic fever of M. Pinel." Dr Latham, too, after remarking that the perplexities with which the diagnosis of the diseases of the pericardium is beset, are more considerable than any belonging to the inflammatory class of diseases in other organs of the body, has mentioned some cases in which the symptoms that manifested themselves during life were those which usually attend inflammation of the brain, whilst, upon examination after death, the brain and its coverings were found in a perfectly healthy and natural state, and the pericardium alone, or conjointly with the substance of the heart, discovered unequivocal marks of acute and recent inflammation. "These cases," Dr Latham continues, "furnish specimens of the enormous difficulties which medical men have sometimes to contend with in the diagnostic part of their art, and they ought to mitigate the censure of those who would judge harshly of our mistakes. Here it is remarkable, first, that a vital organ should sustain an acute inflammation without any symptom whatever immediately referrible to itself, and that organ the heart; and, secondly, that it should impart expressly to another organ, not the mere symptoms of common derangement, but the authentic symptoms of inflammation, and that organ the brain. Diagnosis is necessarily perplexed and baffled where no symptoms whatever are found in the organ really diseased, and none in those with which it is functionally allied, but in some other organ with which it has no known connection, save that they are both parts of the same body. And, further, diagnosis becomes absolutely hopeless when the organ, thus suffering sympathetically, puts forth, not the sign of a mere indefinite ailment, but of a real disease, changing and disorganizing its structure; as when the brain, being perfectly healthy, manifests the signs of acute inflammation, while the heart, being acutely inflamed, gives no evidence of its disease whatever."

Of the cases in which the medical practitioner is misled by the symptoms that present themselves, as to the nature of the malady under which his patient is labouring, this arises, in some, from a local affection producing the symptoms of a constitutional disease, without betraying any marks of its own existence; whilst in other instances, on the contrary, it depends upon a constitutional disease, simulating, or producing the symptoms of a local affection.

A learned journalist, in quoting a case related in Hufeland's Journal by Dr Roeser of Wurtemberg, in which inflammation of the heart had assumed the symptoms of chorea, or St Vitus's dance, has justly remarked, that "the medical practitioner is not unfrequently puzzled by nervous affections taking on the character of serious organic diseases; he should be on his guard against the reverse, dangerous maladies concealed under the mask of nervous disorders." (Johnson's Journal, July 1829.)

"In local diseases," says Sir Everard Home, in his work on Strictures (ii. 13), "it is often difficult, and sometimes impossible, to ascertain whether the constitutional affections that are met with are in reality symptomatic of the local irritation, or belong to some new disease which has been superinduced; and for want of some criterion to guide our judgment in the investigation of diseases, we too often mistake the occasional symptoms for the disease itself, which, from the obscurity of its situation, or its apparent insignificance, is totally neglected." "The constitutional symptoms which belong to a stricture in the urethra," he adds, "have been more frequently mistaken for an original disease, than those of any other local complaint; and it is only within these few years that this error has been detected." And to the same effect Dr Thomson observes, in his Lectures on Inflammation (p. 105), that "of fevers resembling intermittent, and arising from local diseases, we have examples in the febrile affections which not unfrequently accompany strictures in the urethra. I have repeatedly known," he adds, "these symptoms mistaken for, and treated as, a true intermittent fever."

It is well known that the "new medical doctrine," maintained by M. Broussais, proceeds on the assumption that certain diseases usually regarded as constitutional or essential, that is, as not proceeding from nor depending on any local affection of a particular organ or texture, always result from certain local internal inflammatory affections, though in some instances there may not occur any well-marked symptoms indicative of the existence of such affections. "All the essential fevers of authors," says M. Broussais, "are referrible to gastro-enteritis (inflammation of the stomach, and adjacent part of the intestines), simple or complicated. Medical men have all overlooked this inflammation when unaccompanied by local pain; and even when pains have occurred, they have always been regarded as accidental." (*Propositions de Médecine*, cxxxix.) It would be out of place to enter here on an exposition of the errors involved in this fundamental principle of the so-called physiological doctrine of medicine; but whatever may be thought of the doctrine which represents all fevers as originating in and referrible to some local inflammatory affection, it must be allowed, that local inflammations occasionally assume the symptoms and course of particular forms of fever, so as to mislead the practitioner in his judgment as to the nature of the disease which he has to treat. "Before entering," says Professor Van Coetsem of Ghent (*Recherches Cliniques*, &c. p. 91), "on an elaborate discussion as to the diagnostic value of the local symptoms which manifest themselves during the course of acute arachnoiditis (inflammation of the serous membrane of the brain), we have thought it right to fix the attention of the medical public upon a singular modification of this inflammatory affection, of which we have hitherto in vain sought for any notices in the works of the different authors who have described this affection, if we except only Pinel and Morgagni, who relate with astonishment some scattered observations, which they have, as it were, left to their successors to make use of, when, having become more numerous, they might serve as the foundation for a medical doctrine applicable to analogous cases. We mean to say that this terrible inflammation may sometimes simulate the paroxysms of quotidian or tertian intermittent fever. This result, founded directly on observation, is of the highest importance as regards the treatment; for if, unfortunately, the physician deceives himself respecting the nature of the pretended febrile paroxysms, which are observed at the commencement or during the course of the disease, he loses successively all the patients committed to his care." "Resting on the observations of our predecessors, and on those which we have ourselves collected, we think we may affirm, without fear of being taxed with rashness, that there are acute inflammations of the serous system which sometimes affect the periodical form of intermittent fevers; and that, of these, acute arachnoiditis presents, during its course, more frequently than the inflammations of other serous membranes, the periodicity in question." (P. 121.)

Constitutional diseases may simulate local affections.

It would appear that under peculiar states of the general constitution, the groups or trains of symptoms characteristic of diseases appertaining to particular organs may manifest themselves, though there do not exist in these organs any morbid conditions, pathological states, or proximate causes, such as those upon which the occurrence of these diseases usually depends. Thus, for example, in certain states of the general constitution, all the symptoms which indicate an apoplectic attack may occur, whilst, from circumstances developing themselves in the progress of the affection, the practitioner has the assurance that no vascular turgescence of the brain, nor serous nor sanguineous effusion, such as genuine apoplexy depends upon, has actually taken place. As illustrative of those states of the general constitution in which such fallacious or simulating diseases occur, we may refer to that induced by the morbific agent which produces ague or intermittent fever, to the gouty habit or diathesis, and to the hysterical.

Ague.

We shall give a few illustrations of the influence of each of these forms of constitutional disease in inducing phenomena analogous to those of particular local affections; and, first, of ague. Sydenham, in the account he has given of the epidemic diseases which prevailed from the year 1675 to 1680, in speaking of the intermittent fevers of 1678, makes the following observation (*Epistola Responsoria, 1ma*, p. 22–3, edit. sec. Londini, 1685; also Works, London, 1742, p. 284, § 34): " Here it is proper to be noticed, that during the first years of this constitution, a very remarkable symptom sometimes succeeded these intermittents; for their paroxysms did not begin with chilliness and shivering, afterwards succeeded by a fever, but the patient was seized with precisely the same symptoms as if he had been affected with true apoplexy, though, however closely it resembled this affection, the ailment was nothing more than the fever itself attacking the head, as was shown by the colour of the urine and other symptoms. Although in a case of this nature all kinds of evacuations seem to be indicated for producing revulsion of the fluids from the brain, as is wont to be done in primary apoplexy, yet these means must be altogether abstained from, as being wholly opposed to the original cause of this symptom, viz. the intermittent fever, and endangering life, as I have myself known. But, on the contrary, we must wait till the paroxysm disappears spontaneously, at which time the bark, if it could not be administered at an earlier period, must be given as soon as possible, and sedulously repeated in the intervals between the paroxysms, till the patient be perfectly recovered."

Dr Morton, in his treatise *De Morbis Acutis, Universalibus*, published in 1692, has dedicated a chapter to the consideration of the proteiform character of intermittent fever. He observes that intermittent fevers are wont not unfrequently to assume the appearance of several other diseases, some of them of a very acute character. "These diseases yield to the power of bark, the great specific for the cure of ague; and if bark be not administered, they often prove fatal. No one hitherto," he continues, " so far as I know, has treated of this subject, though its investigation seems to me of the greatest importance for the promotion of practical medicine. Among the innumerable symptoms that usually accompany intermittent fevers, there is no one which does not sometimes rise to such a degree of intensity as to bring the life of the patient into immediate danger, whilst at the same time the type of the fever, in its various stages of chill, heat, and sweating, is completely obscured, so that we are not able to detect the existence of the fever by its usual characters. Sometimes it presents itself to the physician under the mask of a fatal chill; sometimes of an unceasing vomiting, of a griping diarrhœa, of cholera morbus, of colic, of periodical hemicrania, of apoplexy, syncope, rheumatism, of universal spasm, pleurisy, peripneumony, pleurodyne, or of some other disease; and though the remedies be administered that are suitable to the particular disease the form of which it assumes, no benefit is obtained from their use, and it is only by the administration of bark that the symptoms are relieved." (Exercitat. i. chap. ix.)

The class of cases to which Sydenham and Morton refer in the passages which we have quoted, have generally been designated as instances of *larvated* or *masked* intermittent fever. But they have not at all times been distinguished with sufficient accuracy from other instances of intermittent fever, in which the symptoms of some severe local malady have manifested themselves in complication with, and not to the exclusion of, the ordinary febrile symptoms of ague; a form of disease to which, from its dangerous character, and frequent rapidly fatal termination, the name of pernicious intermittent fever has been given by Torti and other writers on this subject.

Gou

That the gouty or arthritic constitution frequently gives rise to phenomena which simulate very accurately the symptoms of local diseases, although the usual proximate causes of these diseases do not exist, the following passages from Musgrave, a very distinguished writer upon gout, may satisfy our readers. " The diagnosis of anomalous arthritic affections," says this author (*De Arthritide Anomala*, Exoniæ, 1707, § iii.), " is surrounded by a great many difficulties, and involved in very deep obscurity." " Indeed those anomalous affections which occur without being preceded by any regular paroxysm of gout, imitate so closely the legitimate and well-marked diseases of the parts which they affect, that it may be considered wholly impossible to discriminate between them. If, for example, angina or quinsy occurs in a person previously healthy, and who has never suffered a single paroxysm of gout, nor shown any tendency to it, and no point of difference can be detected between the symptoms of this case and the ordinary ones of genuine angina, who would dream that this affection was dependent on gout? yet that a gouty angina may occur under such circumstances is established by medical experience beyond all possibility of doubt." " With regard to the inward part or trunk of the body," observes Musgrave (lib. cit. § viii.), " anomalous gout most frequently seizes upon the stomach and intestines. Hence arise anorexia, dyspepsia, vomiting; hence colic, dysentery, diarrhœa, and hence sometimes arthritic abscess. Frequently it attacks the head, exhibiting at one time the appearance of vertigo, at another of headach, and at another of arthritic apoplexy. Not unfrequently it makes its attack upon the region of the chest and the organs of respiration, presenting itself under the form of asthma, or of cough, or of hœmoptysis, or of arthritic phthisis. Sometimes it even attacks the fauces, assuming the characters of angina; sometimes the gums, receiving the name of gout in the teeth. Sometimes, in seizing upon the kidneys, it produces the symptoms of calculus, dysuria, and strangury. In fine, it lays hold of the viscera, the membranes, the muscles, the glands, the tendons, the ligaments, perhaps even the bones; so that throughout the whole trunk there can scarcely be found a part which is totally exempt from it." " It is well ascertained," adds this author in another place, " that the affections thus produced by this wandering poison (*devio miasmate*), simulate most accurately all the diseases to which the parts in which they occur are subject; assume their characters, exhibit even their pathognomonic symptoms, and can in no ways be distinguished from the indigenous diseases by the concurrent diagnostics, but, on the contrary, are in fact frequently confounded with them."

Hyst

We have mentioned hysteria as another of those states of the general constitution that are liable to give rise to groups or trains of symptoms closely resembling those which are in wont to arise from morbid conditions of particular organs. Sydenham, in speaking of hysteria, observes (Works, uti cit. p. 370), that " this disease is not more remarkable for its frequency, than for the numerous forms under which it appears, there being scarcely any diseases with which mankind is afflicted, of which it does not assume the semblance. For, of whatever part of the body it may take possession, it immediately produces symptoms corresponding to that part, so that unless the physician be a person of judgment and penetration, and of considerable experience in practice, he will be deceived, and suppose these symptoms to arise from some essential disease of this or that particular part, and not from the hysterical affection on which it really depends."

"Among the diseases which Sydenham had observed to be counterfeited by hysteria," says an able writer in Rees' Cyclopædia (art. HYSTERIA), "are apoplexy, which terminates in hemiplegia, and is chiefly seen in lying-in women, after difficult parturition attended with great hæmorrhage: the clavus hystericus, or acute pain in one small spot in the head, which is often accompanied by vomiting and palpitation of the heart; this is most frequent in delicate and chlorotic girls: pain in the stomach, cholic, with porraceous vomiting, resembling the iliac passion, terminating in jaundice, and always accompanied by great despondency; chiefly attacking women of lax fibre, who have suffered severe labours from large children: pains in the kidneys and bladder, like fits of the stone, with suppression of urine; occurring in women much debilitated by previous hysteric fits, and in a bad state of health, who are also liable to long-continued vomiting and diarrhœa without pain, discharging green bile. He likewise remarks, that the disease is liable to attack the external parts and muscular flesh, sometimes causing pain, sometimes swelling, in the throat, shoulders, hands, thighs, and legs, more especially in the last, which swelling, however, is to be distinguished from œdema, by being greatest in a morning, by leaving no pit after pressure with the finger, and by commonly affecting only one leg, though its external appearance much resembles that of œdema. But the most severe of those pains is that which affects the back. Sydenham adds, that these pains have this circumstance in common, that they all leave the parts extremely sore and tender, as if they had been severely beaten, so that they cannot bear the touch for some time; and that these pains and other symptoms are all preceded by a death-like coldness of the external parts." (*Diss. Epistolaris*, edit. sec. Londini, 1685, p. 124, seqq. Works, ut supra cit. p. 370.)

Dr Ferriar, in his essay on the Conversion of Diseases (Med. Hist. and Reflections, ii. 17), in speaking of hysteria, remarks that, "whoever would present us with a good book on the fallacy of symptoms, which is greatly wanted, must be completely master of this unaccountable disease." "I have met," says he, "with several cases of hysterical hœmoptoe, in which the quantity of blood evacuated was very considerable; six or eight ounces were sometimes spit up daily, for a fortnight or three weeks successively. Most of the usual symptoms attended which denote danger in this complaint when it arises from other causes; but the equal, moderate state of the pulse, and the appearance of some degree of the *globus hystericus*, seemed to determine the nature of the complaint; a conversion, accordingly, soon took place to the ordinary hysteric paroxysm, and no bad consequence followed the hæmorrhage from the lungs." "In one case," says the same author, "the bowels were attacked, and the symptoms of *enteritis* (inflammation of the bowels) were so precisely imitated, as to give much alarm for the patient's safety. I suspected the real nature of the disease from observing that the pulse was soft and full, that the evacuations were natural, and that her spirits were agitated, even to involuntary emotions, by slight causes.' This case terminated successfully on the accession of clear hysteric symptoms." "Several years ago, I attended an elderly lady, for a complaint which seemed to vibrate between apoplexy and palsy. After lying for several weeks in a state which afforded little hope of amendment, she saw affected with involuntary sobbing and weeping; the complaints in her head and limbs were converted into hysterical convulsions, and she recovered completely. It is very common to meet with syncope, or palpitations of the heart and great vessels, accompanied with a soporific depression, or extreme dejection of strength and spirits, and converted, after deep sighing or discharge of tears, into the hysterical paroxysm. In these cases the pulse is sometimes full and regular during the most alarming appearance of sinking; and sometimes variable to such a degree as to exclude all conjecture, excepting that of an hysteric origin." (Pp. 29, 30, 32.) It would be easy to swell to a large amount our quotations illustrative of the great variety of diseases which hysteria occasionally simulates. But we must content ourselves with referring to the account which Dr Marshall Hall has given in his work on Diagnosis (p. 214), of hysteric croup and hysteric pleurodyne; to some cases of hysteria imitating inflammatory action, paralysis, &c., which are related by Dr Bright in his very valuable Clinical Reports (ii. 452); and to a selection of cases presenting aggravated and irregular forms of hysteria, &c. by Mr Laycock, published in the 134th and subsequent numbers of the Edinburgh Medical and Surgical Journal.

In some cases it is not a single form of disease only of which an hysterical state of the constitution induces the phenomena, but several different forms of disease may be simulated in succession. "When the hysteric disposition is set in motion," says Dr Ferriar (p. 31), "it is not uncommon to find many of the different viscera attacked by it in turns, and the disease peculiar to each counterfeited with much exactness. I have seen symptoms of paralysis, jaundice, palpitation, and nephritis, succeed each other rapidly in the same patient, while some of the characteristic marks of hysteria have been discernible, and where the unity of the disease was proved, by the disappearance of all menacing affections on the approach of regular fits."

Difficulty of distinguishing between specific and non-specific diseases.

It is well known to medical men that there are certain diseases which possess what is called a specific character, that is, which depend on the introduction of a peculiar poison into the system, animal or mineral, such as those of syphilis, and of lead, or on a peculiar state of constitution, sometimes hereditary and sometimes acquired, such as cancer. These diseases, in their general features, resemble affections of a simple or non-specific character. Hence it is not unfrequently a matter of great difficulty, when affections present themselves resembling in their symptoms those which are known to be produced by specific diseases, to determine whether or no there exists in the constitution such a modifying influence as should communicate to these affections a specific character, or whether they be the results of diseased action in a constitution not peculiarly modified. Thus, it is well known how much controversy has arisen among medical men as to the possibility of distinguishing the various symptoms of syphilis from analogous affections occurring independently of the operation of the syphilitic virus. "There is hardly any disorder," says Mr Hunter, "that has more diseases resembling it in all its different forms than the venereal disease." (On the Ven. Dis. p. 380.) In the same way, it is, in many instances, impossible to judge, by the symptoms which present themselves, whether an affection, as of the breast, of the lymphatic glands, of the tongue, &c. ought or ought not to be considered as cancerous; and it is only the melancholy distinction of incurability that ultimately clears up the diagnosis. Again, when lead is introduced into the economy, as it may be in a variety of ways, it is liable to give rise to a certain combination of symptoms which, from the predominance of abdominal pains, and the retraction of the belly, bilious vomitings, and obstinate constipation, with which it is accompanied, is usually designated lead *colic*. But the symptoms of lead colic, as M. Andral has observed, sometimes manifest themselves in persons who have not been subjected to the influence of any saturnine preparation. (*Malad. de l'Abdomen*, p. 507.) To the same effect, Dr Graves, in the conclusion of a clinical lecture, published in the Lond. Med. Gaz. for 26th February 1831 (vii. 675–6), has suggested, “that perhaps the following *general law* will be found applicable to the effects which poisons produce on the constitution, viz. that all poisons give rise to a train of symptoms, constituting a certain disease, of which we may always find a counterpart among those diseases which arise in the system from other causes. Thus, symptoms exactly resembling those of colica pictonum (or lead colic) may occur where no lead has acted on the system; and the remarkable epidemic paralysis of the extremities observed in Paris in 1828 bears a striking resemblance to the paralysis caused by lead. If time permitted me to enter upon this subject,” adds Dr Graves, “I think I could succeed in bringing forward examples of morbid states of the system, in which symptoms similar to those arising from mercury, arsenic, narcotic poisons, &c. are produced totally independent of the ingestion of these substances.”

Resemblance of different diseases may be limited to their commencement,

The resemblance in the groups or trains of symptoms produced by different pathological conditions, which is liable to embarrass the practitioner, or lead him into error in forming his diagnosis, exists in some instances only during a particular period of the course of the disease, as at its commencement or termination. Thus, for example, a great many diseases, in their incipient stages, exhibit the general characters of fever, without any symptom manifesting itself by which the physician can be enabled to foretell whether, in its progress, the disease will prove to be of the nature of simple fever, or one of the various forms of febrile eruption, or whether an inflammatory affection is about to develop itself in one or other of the internal organs of the body. Unless there happen to be some adventitious circumstances, by which in such cases the judgment can be assisted, as, for example, the presumption afforded by the knowledge of exposure to a specific contagion, the practitioner must wait for a more advanced stage of the malady before he can pronounce with confidence upon its nature. M. Pinel, in noticing some remarkable varieties which mania presents at its first commencement, remarks, that “the extreme intensity of the symptoms may sometimes lead to error, and the name of mania may be given to a malignant or ataxic fever; for, besides that the same causes may equally produce one or other of these diseases, they may also exhibit common characters, violent agitations, furious delirium, alternations of stupor and nervous excitement; sometimes a marked acceleration of the pulse, dryness of the tongue, a pale and exhausted countenance, slight and interrupted sleep, and an entire rejection of all nourishment. The distinction is then difficult to make at the commencement, and it is only by watching the disease for several days that the practitioner can arrive at a positive conclusion.” (*Sur l'Aliénation Mentale*, Paris, 1809, p. 59–60.)

or to their termination.

As there is in many instances a close resemblance in the symptoms by which different diseases commence, so also it frequently happens that diseases of different natures, at an advanced stage of their course, give rise to some determinate group of symptoms which mask or conceal those of the primary disease, and themselves assume the prominent character. Thus various organic diseases situated in different organs or parts are liable to induce, at an advanced period of their progress, the state of dropsy; and when the dropsical effusion has once attained a considerable extent, it frequently masks the symptoms of the original disease so much as to render it difficult, if not impossible, to ascertain its nature, from the consideration of the existing symptoms. It would appear, however, from the results of recent clinical observation, that if the practitioner is able to ascertain in what situation the dropsical effusion commenced, and to trace its progressive extension to other parts of the body, these circumstances of themselves often afford sufficient data for determining in what organ the morbid condition is situated on which the production of the dropsy depends.

So much for the circumstances under which the practitioner may be embarrassed or misled in his judgments respecting the seat and nature of diseases, from resemblances in the group or train of symptoms produced by different pathological conditions. The next source of difficulty and fallacy in the diagnosis of diseases which we propose to illustrate, arises from the fact that the group or train of symptoms produced by a particular pathological condition, or concourse of pathological conditions, in one individual, may be very different from the group or train of symptoms produced by an apparently identical lesion in another individual. This production of two or more different groups or trains of symptoms in different individuals, by a pathological condition or proximate cause that seems to be identical, may occur, as will appear from the illustrations which we shall adduce, whether the pathological state or lesion be organic or simply dynamical.

The diversity in the group of symptoms attending a particular morbid condition, which misleads a practitioner in his diagnosis, may extend to the whole or greater part of the symptoms, or be confined to one symptom, or to a few only. In the latter case the deviation from the ordinary characters of the disease may consist either in the presence of a symptom or symptoms that do not usually attend the morbid condition which exists, or in the absence of symptoms by which it is usually accompanied. The disease drops, as it were, some of its usual characters, or assumes some that appertain to other diseases. “A disease,” says M. Rostan (*Méd. Clin.* ii. 355), “without being entirely latent, may want many of its characteristic symptoms; and this circumstance must occasion great difficulties in diagnosis. This is of frequent occurrence in cerebral diseases. Thus, when softening of the brain is unattended by precursory symptoms, its diagnosis is of extreme difficulty.” “Cerebral hæmorrhage,” says the same author, “may exhibit precursory symptoms, and cerebral softening want them. How, in such a case, can these two affections be distinguished?” Pain being a symptom to which the attention of the practitioner is always forcibly directed by his patient, much reliance is usually placed on its presence or absence in the diagnosis of diseases, and particularly in discriminating between those which are and those which are not inflammatory. It is far, however, from being an infallible sign. “The signs of the different alterations of which the kidney may be the seat are,” observes M. Bouillaud (*Journ. Compl.* xxxi. 13), “very obscure. All that semeiologists have said on this subject is far from being exactly conformable to observation. We may easily conceive why the diagnosis of affections of the kidney presents so many difficulties, if we reflect, 1*st*, that the depth at which that organ is situated withdraws it almost entirely from our means of exploration; 2*dly*, that the disturbance of its functions produces phenomena which may equally be occasioned by different diseases of the bladder and ureters; 3*dly*, that pain is not a constant accompaniment of renal affections. If we trusted to most pathologists, the most acute pains should be almost inseparable from inflammation of the kidneys. I do not pretend to deny that this may sometimes be the case, but I can affirm that I have met with incontestable traces of nephritis in persons who had not complained of any pain in the region of the kidneys. This absence of pain in the diseases of these organs is, besides, the more easily conceivable, that they are not sensible in the state of health. It may be added, that it is not very uncommon to observe violent pains in the region of the kidneys in persons who are not affected with any disease of these organs.”

No circumstance certainly tends more to perplex the medical observer, in attempting to determine, from the consideration of the symptoms that manifest themselves in individual cases, what the disease is which presents itself to his observation, than the great diversity which a disease may exhibit in its phenomena, according to a variety of circumstances not at all times easily appreciable; such as atmospheric influence, individual constitution, or, perhaps, mode of treatment. Those diseases that arise from the action of a contagious principle afford us the best opportunity of noticing the great diversities of appearance which the same disease may exhibit in particular epidemics, and as modified by diversity of constitution, mode of treatment, &c. If we compare, for example, the severest and the mildest case of typhus fever, or of smallpox, or scarlet fever, we shall have difficulty in believing that they are instances of the same diseases. Yet, in examining a considerable number of cases of any one of these diseases, we shall be satisfied, that between these extreme points there is a series of intermediate links which exhibit the most gradual transition from the most mild to the most severe.

In the diseases to which we have just alluded, we are unable to detect after death, when it occurs, any structural morbid conditions of the different textures, systems, and organs of the body, as being constantly and necessarily present, so as to justify us in regarding them as the proximate cause of the symptoms that manifest themselves; and this circumstance must no doubt add considerably to our difficulty in determining what are the essential and characteristic symptoms by which we should be able to recognise these diseases under the great diversity of appearances which they present in particular cases. But even in diseases in which we meet with structural alterations on examination after death, and these too having proceeded, in some cases, to a very considerable extent, we often find that there had been great diversity in the groups or trains of symptoms by which, in different individuals, the same structural change had been attended.

The various affections to which the contents of the cavity of the cranium are subject, furnish numerous illustrations of the fact that the same structural morbid condition may be attended in different cases by different groups or trains of symptoms. M. Andral, in his *Resumé* (*Malad. de l'Encephale*, p. 522) of the cases which he has published illustrative of softening of the hemispheres of the brain, observes, "In showing us the softening of the brain under all its forms, both anatomical and symptomatical, the preceding cases have shown us also how far the diagnosis of this affection is from being in all instances easy." "In each of the cases, it is not only that the symptoms are not the same, but that the same symptoms are combined, or succeed each other in the most different ways. Hence there result for one particular anatomical lesion, several forms of disease, which, in a nosological table, might be placed at a great distance from one another. In some cases the nosological disease is what is called an attack of apoplexy, with or without loss of consciousness; in others, it is a so-called ataxic or malignant fever; and in others, again, it is a gradual diminution either of motion only, or of intellect and motion at the same time." To the same purpose Dr Abercrombie remarks, that "when we endeavour to trace the leading symptoms connected with the different forms of organic diseases of the brain (comprehending under that name permanent changes of the cerebral substance itself, and new formations within the head), we do not find any uniformity, by which particular symptoms can be distinctly referred to the various forms of the morbid affections." He afterwards alludes to the extreme difficulty of fixing upon any general principles, or of referring the particular character of the symptoms to any thing in the seat or nature of the disease. "Tumours, for example, will be found, in one class of cases, unaccompanied by any remarkable symptoms; while, in other cases, tumours in the same situation, and of no larger size, are accompanied by blindness, convulsions, or paralysis. It does not appear that these diversities depend either upon the size of the tumours, or, as far as we know at present, upon their particular structure. But these points remain to be investigated; particularly what diversity of symptoms is connected with the nature of the tumours, and especially with their characters, as being tumours distinct from the cerebral mass, or as being indurations of the substance of the brain itself." (On Diseases of the Brain, third edit. p. 316, 322–3.)

Thoracic diseases.

In the viscera of the chest, as well as in those of the head, examples are to be met with of the same structural morbid condition giving rise, in different persons, to different combinations of symptoms in concourse and succession. Thus, Dr Latham, in illustrating his observation, that one of the common difficulties attending the diagnosis of pericarditis is referrible to the variableness of its own symptoms, remarks (Lond. Med. Gazette, iii. 211): "Disease belongs most unequivocally to the heart when pain is immediately referred to it, and when its action is disturbed. And when there is fever withal, it bespeaks the essence of the disease to be inflammatory, and fixes it, almost to a certainty, in the pericardium. But why in the pericardium more than in other parts of the heart? Because it is matter of experience, that, above all others, the pericardium is liable to acute inflammation in an incalculable proportion. But, strange to say, the pericardium may be acutely inflamed, and yet there may be no pain. And the disturbance of the heart's action is so little of one kind in all cases of pericarditis, that no certain mode of disturbance can be relied upon as a diagnostic symptom; and though fever may be present wherever there is pericarditis, there is often, at the same time, inflammation of some other organ, out of which it may arise."

Abdominal diseases.

Nor are the viscera of the abdomen more constant in respect of the symptoms by which their several structural pathological conditions are attended, than those of the head and chest. Dr Coe, after describing the ordinary signs of biliary concretions when they are making their way through the ducts, remarks (lib. supra cit. pp. 145–6, 147–8) that these "do not happen precisely alike in all persons, but will be found to vary in different patients, and even in the same person at different times, as well as to the number of the symptoms as the degrees of them, and the order in which they come on. Which variations," he continues, "will arise from several causes (in like manner as we see happens in other diseases), according to the difference of constitutions and other circumstances, and according to the size and shape, and perhaps other properties, of the calculi, as also of the ducts through which they pass. From which variation of the symptoms there sometimes arises an obscurity and uncertainty in judging of particular cases. So that we may have good reason to suspect that the disorder is occasioned by a stone, though we cannot be clear enough to pronounce that it is so; which at other times we can do with sufficient certainty." "As in the more uncommon and less known diseases, some particular cases may be so strong and clear as to be sufficiently obvious, so in some of the most evident diseases, which are readily known at first view when the train of symptoms is regular and uniform, we sometimes meet with so great irregularity, and such a perplexed combination of circumstances, that we are at a loss to unravel them, and find some difficulty in determining the particular nature of the case."

From the illustrations that have been given of the two last-mentioned sources of difficulty and fallacy in diagnosis, it must be obvious that, in practice, they frequently

Sources II. and III. may occur combined.

occur combined with one another. A concourse of symptoms which we shall designate as A, may arise from two different lesions *y* and *z*; whilst at the same time the lesion *y*, besides giving rise in one individual or class of individuals to the train of symptoms A, may in another individual give rise to a different train B. When, therefore, A presents itself to our notice, we may suppose it to depend on *y* in cases in which it actually depends on *z*. And when B presents itself to our notice, we may fail to detect its dependence on *y*, from its not occurring to us that this lesion can exist without being attended by the symptoms A. "If inflammation of the contents of the cranium always announced itself by the same symptoms," says M. Charpentier, "or if the symptoms by which it usually announces itself did not sometimes depend solely upon simple irritation reflected upon the brain by some organ or organic texture in a state of inflammation, its diagnosis would never be very difficult. This, however, is not the case, for inflammation of these parts occasionally differs so much from its ordinary physiognomy, both in respect of its course and of its symptoms, that the opening of the dead body can alone reveal its existence; whilst at other times simple sympathetic irritation of the brain deceives so much by the perfect resemblance of its symptoms to those which meningo-cephalitis (inflammation of the membranes and substance of the brain) presents, that the sight of the uninflamed condition of these parts can alone undeceive us as to the nature of the disease. Among the number of affections capable of inducing cerebral symptoms which by their concurrence simulate meningo-cephalitis, we must particularly reckon the presence of worms in the intestines, dentition, pneumonia at its height, but, above all, inflammations of the stomach and small intestines." (*De la Nature*, &c. *de la Maladie dite Hydrocéphale Aiguë*, Paris, 1829, p. 195.) M. Rostan, in showing that pain, vomiting, and swelling form the principal characters of cancer of the stomach, remarks (*Médecine Clinique*, ii. 477), "These symptoms, however, may exist, and the disease (that is, the pathological condition of cancer of the stomach) not exist, and *vice versa*, that is to say, the symptoms may be absent, and yet the disease exist. And, in the *first* place, pain appertains to all diseases of the stomach, and cannot be regarded as a special sign of that in question; the same may be said of vomiting; and, lastly, swelling may appertain to a multitude of different lesions. Engorgement of the liver, of the spleen, or of the pancreas, the accumulation of fecal matters in the arch of the colon, aneurismal dilatation of the aorta, and other accidental tumours, may so much the more readily pass for cancer of the stomach, that most of them occasion disturbance of the digestive functions. In the *second* place, the pain may not exist, as happens in cases of indolent cancer, which, as is well known, are not uncommon. The vomiting, also, may not occur, 1*st*, when the pylorus is free; 2*d*, when it is extensively ulcerated; 3*d*, when the whole of the stomach is involved in the disorganization. The swelling may not be sensible, which, so far as regards diagnosis, is the same as if it did not exist, 1*st*, when the false ribs and sternum descend very low, and cover it; 2*d*, when the free border of the liver lies over it; 3*d*, when the subject is pretty stout; 4*th*, when the abdominal muscles contract," &c. "Notwithstanding these difficulties," adds M. Rostan, "it is in general possible to arrive at a precise diagnosis, because it rarely happens that they occur in sufficient number entirely to mask the disease."

Precautions in their application.

But although a train of symptoms apparently identical may arise from different morbid lesions, and different trains of symptoms may arise from what appears to be an identical lesion, it is possible that in neither case does there actually exist the identity supposed. For, notwithstanding the apparent resemblance of the symptoms arising from different lesions, it seems reasonable to suspect that there may exist points of difference between these symptoms, if we were capable of detecting them. And, accordingly, the progress of improvement in diagnosis has in numerous instances brought to light symptoms or marks by which we are enabled to distinguish between different morbid lesions of the economy, that had previously been supposed to produce precisely the same trains of symptoms.

Of many nosological diseases, such as asthma, ileus, and jaundice, it may be said that they afford examples of the same group or train of symptoms, arising from different pathological conditions. Asthma, for instance, understanding by that term "difficulty of breathing returning at intervals, with a sense of oppression in the chest and sibilous respiration, cough difficult at the commencement of the paroxysm, or absent, towards the termination free, with mucous expectoration, frequently copious," may proceed from diseases of the respiratory organs, or of the heart and large vessels, or of the organs belonging to the nervous system. But though on a first view it may appear true in respect of each of the nosological diseases that has been mentioned, and of many others that might be enumerated, that different lesions give rise to the same group or train of symptoms, on more accurate examination it will generally be found possible to detect, in the cases which depend on one pathological condition, symptoms that are absent in the cases which depend upon a different pathological condition; or, though the symptoms of the two sets of cases are the same in their general nature, one or more of them may be found to be differently modified. "We must at all times," observes M. Dalmas, "conform to that rule of logic which teaches that one same effect always results from one same cause. If, in cases which have exhibited the same symptoms during life, we meet, after death, with different lesions, we may be sure that the true seat of the disease has escaped our researches. It is proper to remark here, however, that there are some vague words employed in symptomatology to express general results, for which it would be unjust to pretend that, in conformity with the rule alluded to, we ought always to find a single and identical lesion. The words dyspnœa and palsy are so circumstanced. If there be twenty species of dyspnœa, we need not be astonished if we find as many different lesions capable of producing it." It is upon such diversities in the minor features of particular sets of cases, depending on differences of pathological condition, that nosologists found, or should found, their *varieties* of diseases; and it is by the accurate marking of these diversities that they should seek to improve their systems of definitions.

In like manner, it seems probable, that when different groups or trains of symptoms arise from what appears to be the same morbid lesion, there is in reality some unperceived diversity in the lesion. It may be identical in respect of its nature in the different cases, but different in its seat or in its relations to other parts. For, supposing that in two or more cases the same organ is affected with the same form of disease, it is obvious that there may be considerable difference in the functional disturbance, and consequently in the symptoms that arise, according to the particular part of the organ in which the pathological condition may be seated. In cases of cancer of the stomach, for example, the symptoms vary greatly according as one or other aperture, or the body of the stomach, are affected separately, or in conjunction with one another.

In illustration of the remark, that where the same lesion appears to give rise to different symptoms, there may actually be some difference in the relation of the lesion to other parts, though not adverted to by a superficial observer, we may quote an observation made by M. Cruveilhier in reference to cancerous tumours in the brain. (*Anatomie Pa-*

thologique, folio.) "A point extremely important in the history of these tumours," says he, "is the difference of the effects produced by causes apparently identical. Thus, in one individual, hemiplegia is occasioned by a spheroidal tumour of two inches in diameter, while in another a tumour of four inches may exist upon the brain without any paralysis being induced, though everything is in other respects correspondent as regards the seat and nature of the disease. I think," adds this intelligent author, "that one of the circumstances to which this diversity of result is attributable is the difference of the direction in which the compressing power acts."

M. Lallemand has with much justice observed, in the preface to his work on Diseases of the Brain (p. xvi.), that "The circumstance which has most influence on the concourse of symptoms, is the more or less rapid, the more or less slow course of the disease. This influence is such as to cause that very different pathological alterations manifest themselves by phenomena sufficiently similar to deceive the most attentive observer, simply from their corresponding in their general course or progress. Thus, for example, there is more resemblance between the symptoms of an acute inflammation of the brain, and of a softening of the cerebral substance, and those of an apoplexy, or sudden compression of the brain, whatever be its cause, than between the symptoms of an acute inflammation and those of a chronic inflammation of this organ. In the same way, an encysted abscess has less resemblance, in respect of the external phenomena which it produces, to a recent abscess, than to a scrofulous, fibrous, bony, or hydatid tumour, or a foreign body lodged in the brain. The same," he adds, "may be said of the affections of the arachnoid membrane."

"Reason and common sense," observes Dr Latham, "seem to declare, that there cannot be the same disease of the same organ, and yet the most prominent symptoms be absolutely different. But morbid anatomy is not content merely to contemplate a disease in its general character, and have done with it: it takes into account also the various morbid products and changes of structure accompanying it, or resulting from it. In pericarditis it takes cognizance of the lymph deposited upon the surface, and of the fluid effused into the cavity of the pericardium; the different quantities of each in different cases, and the different proportions which they bear to each other. It notices, also, that the lymph sometimes contracts a partial and sometimes a complete adhesion, and sometimes none at all; that the fluid is sometimes freely effused into the pericardium, and envelopes the whole heart; and is sometimes limited by adhesions to a part of it. These conditions must influence the action of the heart in various ways; and morbid anatomy, knowing these things, suggests to clinical observation, with respect to pericarditis, that as its products are different, so too must its symptoms be in different cases, and even in the same case at different periods." (Lond. Med. Gaz. iii. 212.) These observations are well calculated to excite the most minute attention, on the part of medical observers, to the less obvious differences in individual symptoms or groups of symptoms produced by different lesions, and to the less obvious differences in particular lesions which seem to give rise to different symptoms or groups of symptoms.

V. m- licat s f les s

The last source of difficulty and fallacy which we have to notice as occurring to the medical practitioner, in attempting to judge, from the symptoms that manifest themselves in any particular case, as to the seat and nature of the disease with which his patient is affected, arises from the circumstance, that two or more parts may be the seats of morbid conditions in the same individual at the same time, whether these morbid conditions shall correspond or differ in their nature, and whether they shall have come on simultaneously or in succession. Such a complication of pathological conditions will possibly produce a complication of symptoms which may render it very difficult for the practitioner to ascertain how many parts are disordered, where the principal seat of disorder is, what part was primarily affected, and how far the disorders in the others depend upon that of the part first affected. Thus, if we suppose an individual to be labouring at the same time under the symptoms of disorder of the stomach and of disorder of the heart, the practitioner may experience considerable difficulty in determining whether the symptoms of deranged digestion and those of disordered circulation are referrible to two distinct primary morbid conditions, or whether one or other of these groups of symptoms is not produced sympathetically; whether, whilst one of the groups arises directly from a primary morbid condition of the corresponding organ, as those of indigestion from disease of the stomach, the other group of symptoms, those of disordered circulation, may not depend on sympathy of the heart with the stomach, rather than on a primary morbid condition of the heart itself.

producing complications of symptoms difficult to unravel;

In the case just supposed, the co-existence of two distinct pathological conditions in the economy is obviously accidental, there being no necessary bond of connection between them. But in other instances, from the dependency of different organs and functions upon one another, the existence of diseased action in one organ may occasion diseased action (whether of a simply dynamical or of an organic character) in another. Thus, it is now well established, that in a large proportion of cases of disease of the heart, the change of structure or of action which this organ undergoes is occasioned by an interruption to the circulation of the blood through some other organ of the body, as, for example, through the lungs, in consequence of previous disease of these viscera. Hence, in the progress of cases of this kind, the symptoms belonging to the organ in which the impediment to the circulation exists, come to be complicated with those immediately referrible to the altered condition of the heart, occasioned by that impediment.

The reciprocal dependency of the stomach and liver on one another furnishes us with another example of complication of morbid lesions producing complication of symptoms. "It must be admitted," says Dr Cheyne (Cases of Apoplexy, &c. Lond. 1812, p. 171), "that it is often difficult to know to which viscus of the abdomen we ought to refer the uneasy sensations that attend imperfect digestion. When disease of structure is apparently confined to the liver, the patient has been known to suffer greatly from dyspeptic symptoms (that is, symptoms of derangement of stomach)—great anxiety, sickness, flatulence, and prostration. And, on the contrary, when the stomach alone appears to be the seat of disease, there is not unfrequently an imperfect or redundant secretion of bile (indicating derangement in the action of the liver), with listlessness, depraved sensation, tædium vitæ, &c. The work of the stomach is never well performed unless when the liver is sound, and the functions of the liver equally require a healthy condition of the stomach. As when either viscus is in a diseased state, the uneasy sensations felt in consequence are referrible to both, the stomach and liver are to be considered, in their morbid states, as firmly linked as in health. But in practice it is of consequence to discover in which organ disease has begun; for, if we are able to restore the organ primarily affected, the organs sympathetically drawn into disease will often return to a healthy state in consequence."

The supervention of a new morbid condition in a person previously labouring under some complaint, whether in the same or in a neighbouring organ, is very liable to be overlooked till it has made considerable progress, in consequence of the premonitory and early symptoms being suffocated, as it were, in those of the original malady. And if in a case in which there exist two or more distinct pathological conditions at the time of the physician's examination, the morbid phenomena or symptoms produced by one of them be, from the nature or the seat of the organ affected, much more apparent than those produced by the other, then it may very readily happen that the practitioner, having satisfied himself of the existence of the more considerable pathological condition, may take it for granted that this is in itself sufficient to explain all the phenomena that present themselves, and thus fail to detect the existence of the other pathological condition, upon which the less marked, though perhaps not the least important, portion of the symptoms actually depends.

or modifying or obscuring one another.

But it is not the mere circumstance of complication, and the difficulty of separating the symptoms arising out of different co-existing pathological conditions, into their respective groups, that render cases of this kind puzzling and perplexing to the practitioner. It frequently happens that the symptoms of one or other, or possibly even of both, the co-existing pathological conditions, are modified in such a degree as to throw over them a great degree of obscurity. "In many diseases," says M. Melier (*sur le Diagnostique*), "instead of a single organ, or of a single texture, there are two, or a still greater number, affected. It rarely happens, for example, that a mucous membrane is alone affected; it is the same with the skin. It is necessary to attend to this coincidence of several diseases, or rather of several organic foci of disease; for in almost all cases the physiognomy of the symptoms is thereby changed. Two diseases existing in this way together, are far from proceeding as if they existed separately. On the contrary, they modify one another. Sometimes they mutually diminish one another's intensity; at other times one of them, in running through its stages, preserves a preponderating intensity, whilst the other, restrained, so to speak, in its development, advances slowly. The first only attracts attention; but when once it has terminated, the second, which, up to that time, had been slight or unperceived, is awakened, and excites fresh symptoms, which the existence of the other seems to have prevented; as if there were in our economy, as Bichat said on this subject, only a certain amount of strength which cannot exist in excess in one place without being diminished in another, and that nature does not indulge in the development of several diseases at the same time."

"It rarely happens," observes M. Lallemand (p. xix. xx.), "that a patient dies of a simple and single affection. In almost all cases, several organs have been involved simultaneously or successively. Then the symptoms of the one or the other disease predominate; the others are very obscure; and, in all cases, these complications influence one another reciprocally, so as to give an unusual aspect to the concourse of symptoms, and to the progress of the diseases. Formerly, in the examination of dead bodies, attention was paid only to the organ which was supposed to be diseased; and when the alterations did not correspond exactly to the symptoms, medical men were contented with regarding the fact as anomalous; or they supposed they had explained it by attributing it to a peculiar idiosyncrasy; or, better still, they made an abstract being of it, existing by itself, and called it an essential disease. The progress of the different parts of medicine, the exactness that is now bestowed upon the observation of symptoms, and the attention that is given to the examination of dead bodies, enables us to appreciate more accurately than was possible till recent times, the influence of each of these complications on the course and concourse of the symptoms."

In some instances the co-existing pathological conditions, each of which furnishes its particular symptoms to the resulting concourse, are seated in the same organ, or in textures immediately adjacent; as in the investing membranes of parenchymatous organs. "Next to those diseases of the brain," observes M. Rostan (*Méd. Clin.* ii. 355–6), "which do not exhibit any symptom, or what are called latent diseases, there are none more obscure than those which are complicated with one another. Thus, when there exist at the same time several different alterations of the brain, as hæmorrhage and primary or consecutive softening, it is almost impossible accurately to determine the nature of the affection; but as in general we recognise at least one of the alterations, these cases cannot rigorously be regarded as errors." M. Lallemand, in remarking that the pathological alterations of the brain are not always accompanied with the same symptoms, and in pointing out that "this apparent disagreement depends sometimes on the different seat of the affection, sometimes on the age, on the sex, or on the temperament of the patient; sometimes on important complications; and, lastly, at other times on the acute or chronic course of the disease;" adds, "when we compare together cases of affection of the brain and of the arachnoid membrane, exempt as much as possible from complication, we see that they exhibit symptoms very distinct, a particular character (*cachet*); whilst those cases that are complicated, as is most frequently the case, present a mixture of the two orders of symptoms, a circumstance which has not been sufficiently attended to, and which has frequently led observers into error." (Preface, p. xvi.) The same observation has been specially applied by Professor Van Coetsem to the complication of one particular form of cerebral disease, viz. softening, with inflammation of the arachnoid or serous membrane of the brain. "One of the causes," says this author (lib. cit. p. 374), "which seems to us to render the diagnosis of cerebral softening so obscure, is the complication of arachnitis (inflammation of the serous membrane of the brain), sometimes of an acute and sometimes of a chronic character, which frequently accompanies or precedes the morbid degeneration of the substance of the encephalon, and in other instances succeeds to it. In fact, it has more than once happened to us, after conceiving that we had recognised the nature and the seat of the disease by its symptoms, to find in the bodies of those who have died, independently of the lesion of the substance of the brain, which we expected, unequivocal traces of inflammation of the serous membrane that surrounds this viscus, such as adhesion between the different laminæ of the arachnoid, sero-purulent effusion into the lateral ventricles, &c. In such circumstances the *facies morbi* appears to us very doubtful, in respect of diagnosis, because the symptoms connected with each of the co-existing affections are far from being characteristic."

In other instances the different pathological conditions which exist simultaneously have their seats in distant organs. When one of these organs is the brain, the symptoms that might be expected to arise from the diseased condition of the other organ are exceedingly liable to be obscured. "The diseases of the brain," says M. Bourdon (*Principes de Physiologie Médicale*, i. 164), mask the diseases of other organs. Far from requiring opium, cerebral affections serve as such to the whole body." M. Lallemand, in speaking of the influence of cerebral affections on the development of the symptoms of such diseases as may exist simultaneously with them, observes (i. 233), "Whenever the functions of the brain are disturbed, and there exists at the same time an inflammation in some other organ, the pain produced by that inflammation diminishes, and even entirely disappears." "It is not," he adds, "because the pain of the head is greater, that that of the abdomen or of the chest, &c. disappears, for frequently there is no headach in these cases. Nor is it because the inflammation in the brain is more severe, seeing that an effusion of serum or blood may produce the same effect; it is because the pain being the result of a sensation perceived by the brain, whatever deranges its functions will cause this symptom of the inflammation to disappear. But if the inflammation is severe, it is not arrested in its development by the cerebral affection; all the other phenomena continue, because they are not, like the sensibility, dependent on the brain. The disease runs through its course in a manner so much the more dangerous, as it is the more difficult to be recognised, and produces the death which is attributed to the affection of the brain, though this be in reality only accessory. If the body be opened with some attention, we are surprised to find so little relation between the symptoms observed during life and the morbid alterations found after death; and this misapprehension throws discredit on medicine, and on pathological anatomy in particular. It is, therefore, of the greatest importance, whenever we observe any symptom which indicates an alteration in the functions of the brain, not to allow ourselves to be imposed upon by the absence of pain. We must then investigate with so much the greater attention the other phenomena, which, being independent of sensibility and volition, do not vary with the state of the brain." "These proper symptoms are so much the more precious, that, if alterations of the brain mask, so to speak, certain inflammations of the stomach, by causing the disappearance of the pain, it also happens very frequently, by a singular sort of compensation, as it were, that certain cerebral affections produce sympathetically nausea and obstinate vomiting, which might be regarded as symptoms of inflammation of the stomach." "These considerations on the perception of pain apply to all inflammations complicated with cerebral affection."

The influence of delirium in concealing the symptoms of diseases seated in other organs than the brain must be explained upon the same principles. In reference to a case of fever in which, as appeared on examination after death, there occurred perforation of the small intestine, followed by inflammation of the serous membrane of the abdomen, but in which the usual symptoms of these morbid conditions did not manifest themselves, M. Louis takes occasion to observe, that "the most formidable symptoms are usually so completely masked by delirium, that as soon as it declares itself, the diagnosis of diseases that are most easily recognised becomes difficult, and sometimes even impossible." (*Recherches Anatom. Pathologiques*, p. 187.)

In treating of "ramollissement (softening) of the central parts of the brain, combined with serous effusion," Dr Abercrombie remarks, "an interesting modification of this affection is that which supervenes upon other diseases, chiefly of a chronic nature, especially affections of the lungs; and the remarkable circumstance in these cases is, that the pectoral symptoms generally cease after the commencement of the symptoms in the head." (On the Brain, 3d edit. p. 137.)

M. Andral, in speaking of the varieties of pneumonia, or inflammation of the substance of the lungs, observes (*Malad. de Poitrine*, i. 369), that some very important modifications of this disease depend on the absence of one or of several of its usual symptoms, whence results latent pneumonia. "It is well established," he continues, "that an intense inflammation of the parenchyma of the lungs may exist without being announced by dyspnœa, cough, or expectoration. It may sometimes happen, even, that at the same time that these symptoms are wanting, auscultation and percussion themselves cease to reveal the true state of the lung; in this case it becomes impossible to establish a diagnosis. We have already remarked that these latent pneumoniæ are rarely primary, but generally supervene when an inflammation of the lung complicates some other disease." "We have seen," remarks the same author (*Fievres*, p. 441), "in recapitulating the lesions discovered by opening the bodies of the dead, that in severe fevers pneumonia was a very frequent complication, and most frequently a fatal one. If we pass in review the symptoms which have announced this inflammatory affection, we shall find that, in most of the cases, the diagnosis has been very obscure. These intercurrent pneumonic affections have frequently not been announced by any apparent oppression of respiration, nor by any characteristic expectoration. The cough itself was very slight, and the disorganization of the lung might be completed before even any suspicion of the existence of pulmonary inflammation was excited. Hence the indispensable necessity of frequently practising percussion and auscultation in such cases. Lastly, we have seen these two modes of investigation become themselves useless, when the inflammation was settled in the centre, the base, or roots, of the lungs. The absence of all characteristic expectoration in these cases of intercurrent pneumonia may often depend on the circumstance that the patients, having reached the last degree of debility, swallow their expectoration, when they have no longer the strength or instinct to spit it out. But sometimes also it appears that there is really no secretion, and this seems to occur particularly in cases of splenisation, or pultaceous softening of the lungs."

Recapitulation.

We have thus endeavoured to illustrate the various circumstances under which it may happen that, in the examination of a patient, a well-informed medical practitioner may fail to detect the existence of any morbid or pathological condition of the economy, though such a condition actually exists; or, in recognising the existence of some such condition, may form an incorrect judgment respecting its nature or its seat. These sources of error in diagnosis we have attempted to reduce to four general heads, which may be shortly stated in the following terms: 1*st*, Morbid lesions without symptoms; 2*d*, identical symptoms with different lesions; 3*d*, different symptoms with identical lesions; and, 4*th*, complications of lesions and symptoms.

We have seen, in the *first* place, that many changes may take place in the structure of the different textures, systems, and organs of the body, and that even to a considerable degree, without producing any symptoms which attract the notice of the individual himself, or of his medical attendant, in the event of some other ailment giving occasion to the latter to inquire into his patient's state of health; or, at all events, without producing any symptoms calculated to direct attention to the organ or part in which the change has occurred. The causes that may be assigned for this occasional latency of morbid lesions we have endeavoured to refer to the following heads: 1*st*, The lesion being seated in an organ the function of which is not exercised in a conspicuous manner; 2*d*, its being seated in an organ, of the function performed by which we are ignorant; 3*d*, its being seated in an organ that is not essential to the wellbeing of the economy, or that is of trivial importance; 4*th*, the exercise of the function not being prevented by the change that has taken place in the structure of the organ, as happens particularly when the alteration is slow in its progress; and, 5*th*, some other organ exercising the function or supplying the place of that which is injured. We found it necessary to admit, also, that in some instances no explanation of the latency of the morbid lesion can be given; and we may remark, that in explaining the same particular instance of latency, we may sometimes find it necessary to refer it to two or more of the causes which we have mentioned, operating in conjunction.

We have seen, in the *second* place, that a particular, and, to all appearance, identical group or train of symptoms, which in one individual is connected with one form of pathological condition, may, in another individual, be connected with a pathological condition of an entirely different nature. We have seen, that when different pathological conditions or proximate causes give rise to the same group or train of symptoms in different persons, these lesions may be both organic, or the one lesion may be organic and the other dynamical. In some instances the different lesions giving rise to the same group or train of symptoms have their seats in the same organ; in other instances they are seated in different organs or parts of the body, and these different organs or parts may be related to one another simply in the way of contiguity or superposition, or there may exist functional dependencies or sympathetic connections between them. To this head we have referred the class of cases in which lesions of the central portions of the nervous system give rise to symptoms in particular organs of the body similar to those that are produced, or that may be supposed to be produced, by lesions of which these organs are themselves the immediate seats; and that other class of cases in which a central portion of the nervous system exhibits symptoms of being affected with some morbid condition, while in fact it is in some other organ that the primary source of disturbance is seated. We had occasion to observe, that in some of the cases in which one disease assumes the characters that usually appertain to another, it is a constitutional disease which assumes the appearance of a local one; and that in other instances, again, it is a local disease which assumes the semblance of one that is constitutional. Sometimes the simulating disease retains one constant character throughout its progress, while in other instances it assumes in succession a variety of different characters. We have seen that the characters by which certain specific diseases can be distinguished from analogous diseases that are destitute of a specific character, are often far from being obvious, and that consequently the discrimination of these two classes of diseases is frequently a matter of difficulty and uncertainty. We have seen, likewise, that in some cases the community of symptoms between two diseases may exist only during a particular period of their progress, as at their commencement or termination; and that in other cases the community of symptoms may continue during their whole progress.

In the *third* place, we have seen that different groups or trains of symptoms may arise, in different individuals, from pathological conditions or proximate causes that appear to be identical. This seems to occur whether the pathological state or lesion be simply dynamical or organic. We have seen that the diversity in the group or train of symptoms may be confined to one of the symptoms, or to a few only, or may extend to the greater part or to the whole of them; and that it may consist in the presence of a symptom or symptoms not usually attendant upon the morbid condition, or in the absence of a symptom or symptoms by which it is usually accompanied. Under this head we have illustrated, or rather suggested, the influence of external and internal circumstances in modifying the characters which the same disease exhibits in different persons.

In relation to these two last-mentioned sources of difficulty and fallacy in diagnosis, we have seen reason to suspect that when groups or trains of symptoms apparently identical arise from different morbid lesions, and different groups or trains of symptoms arise from what appears to be an identical lesion, it is possible that in neither case does there actually exist the identity supposed; but that the apparent identity is attributable only to our inaccurate observation, or to the imperfection of the means of investigation hitherto ascertained.

Fourth and *lastly*, we have seen that several different pathological conditions, having their seats in the same or contiguous organs or parts, or in organs or parts remote from one another, may exist in the economy simultaneously, whether they shall have come on simultaneously, or shall have followed one another in succession; and, in the latter case, whether they shall stand in the relation of cause and effect, or shall be entirely independent of one another; and that not only may these co-existing pathological conditions, in producing in a more or less marked manner their respective symptoms, give rise to a complication of phenomena which in many instances it is by no means easy to unravel, but they may in various ways modify and obscure the phenomena appertaining to one another.

In illustrating these several sources of difficulty and fallacy in diagnosis separately, it has very clearly appeared, that in a large number of cases they are met with, not singly, but more or fewer in conjunction; a circumstance which cannot fail seriously to increase the embarrassments of the practitioner. Had our space allowed of it, it was our wish, with a view to impress more forcibly on our readers the practical operation of these sources of difficulty in ascertaining and distinguishing diseases, to have traced their influence, separately or variously combined, in rendering difficult and obscure the diagnosis of some one particular disease. For that purpose we had made choice of pulmonary consumption; and it is on this account that, in illustrating the several sources of difficulty individually, we have not taken advantage of the numerous illustrations of these which consumption affords, and which have been so ably pointed out in the writings of Laennec, Andral, Louis, Abercrombie, Craigie, and Clark.

With this recapitulation we must bring to a close our review of the various sources from which those difficulties proceed that the medical practitioner has to encounter, either in detecting the presence of disease in the human economy, or, when its existence is manifestly proclaimed by obvious signs, in discriminating, in individual cases as they present themselves to his observation, the true nature and seat of the affection. To the professional reader, we flatter ourselves, such a review may be not without its use, as tending to bring before him, under somewhat of a systematic arrangement, a number of particular facts, of which, in order to avoid the risk of perpetual errors of diagnosis, it is necessary not only that he should be aware, but that he should be able, in the exercise of his art, readily to recall the recollection, and make the appropriate application. On the general reader, we venture to hope, a knowledge of the nature and extent of these difficulties may tend to impress, *first*, the importance of the friends and attendants of the sick, as well as the sick themselves, not only facilitating such inquiries as the medical practitioner may himself institute, but spontaneously affording every information from which it can be supposed that he may possibly derive aid in forming a judgment respecting the disease under which his patient labours; *secondly*, the inexpediency of urging the medical practitioner to the precipitate expression of an opinion respecting the nature of his patient's malady, which, however incorrect it may be, must, when once it has been pronounced, enlist upon its side both his pride and his interests, and thus render it difficult for him to perceive the true posture of affairs, and even more difficult for him, perhaps, to avow it when perceived; and, *thirdly*, the unreasonableness of withdrawing confidence from a practitioner of whose knowledge and skill they have had manifold personal experience, or sufficient warrant on the testimony of others, because in some particular case or cases the judgments which he has formed may have proved to be incorrect. It has been justly remarked, that "in the practice of physic, there is doubtless a great difference in men as to quickness of apprehension, and also as to the improvement derived from experience; so that one practitioner may discover a difficult case much sooner than another. But there is also a difference in respect of cases.

Some are obvious and easy to proper judges at first view; others are so obscure and perplexed that they are not to be hit off at first sight, nor to be discovered by a superficial inquiry, but require time and attention, with a careful discriminating examination of all the circumstances of the patient, before the true state of them can be determined. Some that are not knowable in their beginning, will become evident in their progress or maturity; and it must be owned there are some that will be too hard for all our inquiry and consideration, and cannot be fully discovered but by the anatomical knife after the death of the patient." (Dr Coe, lib. cit. p. 5, 6.)

As a knowledge of the existence of these difficulties seems calculated to bespeak from the public a more favourable consideration for the practitioner who has availed himself of all those means which medical science affords for improving his acquaintance with diseases and his means of discriminating them, so we cannot but think that there is another purpose to which it may, in some degree, also be subservient. We have already expressed our conviction (art. MEDICINE), that it is vain to trust to any legislative enactments for the suppression of quackery; and that the only mode in which any one can hope to promote this end, is by assisting in opening the eyes of the public to the grossness of the delusions which, in matters relating to medicine, they practise upon themselves, or allow others to practise upon them. But if it be admitted that a knowledge of the nature of the disease under which a patient labours, is an indispensable preliminary to the safe and proper management of his case; and if, in attempting to arrive at this knowledge, so many sources of difficulty and fallacy await even the best-informed medical practitioner,—him who is furnished with all the means of avoiding and overcoming them which the accumulated experience of ages has been able to discover or invent,—the prudent man may hesitate before he admits the belief that these difficulties can be overcome by persons of no scientific instruction, and who professedly reject all aid from the observations or experience of others; he may well pause to consider whether the discrimination of such a person can be with safety relied upon, even in those cases of which Dr Coe speaks as "obvious and easy to proper judges," far less in those obscure and perplexed cases, which require so much skilled observation "before the true state of them can be determined;" and whether the freedom of such a person, from doubt or uncertainty in diagnosis, may not arise from the rash presumptuousness of ignorance, rather than from the reasonable confidence which knowledge is calculated to inspire.

We could have wished, before terminating this article, to have taken a view of the means by which the medical practitioner endeavours to overcome those difficulties, and avoid those fallacies of diagnosis, which we have represented as arising from the uncertain relations that subsist between internal morbid conditions of the economy and their external manifestations or symptoms. The observations we can offer on this subject must necessarily be very brief and imperfect; but we are unwilling to leave on the minds of our readers the impression that medical science has accomplished, and can be expected to accomplish, nothing towards the more accurate determination and marking of these relations, which can aid the practitioner in his diagnostic judgments.

Previously to entering on these observations, however, we would repeat, what we have already hinted, that diligence in seeking out, and precision in examining, the *symptoms* of diseases, are often of themselves sufficient for the correction of those errors into which a less diligent investigation and less precise examination of these phenomena would be liable to lead the practitioner. "There is probably," as Mr Hunter has remarked in his work on the Venereal Disease, p. 379, "no one disease to which some other may not bear a strong resemblance in some of its appearances or symptoms, whereby they may be mistaken for each other. But diseases which resemble others seldom do it in more than one or two of the symptoms; therefore, whenever the nature of the disease is suspected, the whole of the symptoms should be well investigated, to see whether it agrees in all of them with the disease it is suspected to be, or only in part." The judicious remarks applied by Dr Southwood Smith to the symptoms which, in the progress of fever, indicate the occurrence of morbid changes within the abdomen, are applicable, probably, to many other cases of disease. "Their great peculiarity," says he, "which it is as important to know as it is to understand their indication itself, is their want of prominence. They are always to be discerned, or with extremely rare exceptions; but they seldom or never force themselves upon the notice of the careless, or extort the attention of the unobserving: still they are not the less constant in their occurrence because they come without noise, nor is the indication they give of their presence less significant because it is unobtrusive." (P. 288.)

Some physicians, indeed, as we had elsewhere occasion to remark (MEDICINE), have been so much impressed with the fallacies to which those judgments are exposed which medical men form respecting the nature of diseases, from a consideration of their symptoms, that they have gone the length of representing symptoms as of no assistance in diagnosis. "It is not, then, on the symptoms," says a late French writer, "that the diagnosis of diseases must be founded. In order to recognise them, we must go farther back, to their source, and discover the internal and concealed spring which has been the *primum mobile* of the derangements that appear externally. We must investigate the organic lesion which has produced, which keeps up, and renews the symptoms observed. It is this lesion which constitutes the disease; it is it which has induced the disturbance of the functions." "In diagnosis," says the same author, "we must absolutely direct our attention to the organs, and in no degree to the symptoms." Of the propriety of endeavouring to arrive at a knowledge of the pathological state, morbid condition, or proximate cause on which a disease or particular case of disease depends, and of the curative efforts of the practitioner being directed against that pathological condition when it can be ascertained, and not against one or other of the various symptoms to which it gives rise, no doubt can be entertained; but it must never be forgotten, that it is only by an attentive investigation of the symptoms that we can hope during life to arrive at a knowledge of the pathological condition which exists. And it would be easy to adduce, from the same author who speaks of excluding symptoms from our attention in diagnosis, passages fully displaying the incorrectness of these views, or rather showing that the expressions in which they are clothed greatly belie the meaning they were intended to convey. To escape the fallacies into which symptoms are apt to lead us in our conclusions respecting the pathological conditions upon which they depend, we must study them in all their varieties of appearances and combinations. The doctrine of symptoms is in every respect as improvable as any other department of medical science. By the successive labours of medical men, additions are constantly making to the number of symptoms or indications by which we are enabled to arrive at a knowledge of the existence of disease, and of its particular nature and seat. And with regard to those symptoms that have been long familiar to medical practitioners, and constantly employed in characterizing and discriminating diseases, much has been done, and much is doing, in the way of determining more accurately their connection with particular pathological conditions of the economy; so that not only are the means which medical men possess of discriminating diseases, through the medium of symptoms, becoming gradually more numerous, but they are also becoming more valuable.

But when the symptoms actually present are insufficient to guide the practitioner to a satisfactory judgment respecting the nature of the disease before him, are there any subsidiary aids towards the accomplishment of this object, of which he may avail himself?

Previous history of the case.

In the first place, a careful consideration of the previous history of the case, from the earliest development of morbid phenomena to the period of examination, may often afford important assistance. For even in cases in which there exists a striking coincidence between the symptoms produced by two distinct lesions at a particular stage of the progress of one or other of them, there may be such differences either in the concourse of their symptoms at other periods, or in their general course, as to enable the practitioner who is duly informed respecting these particulars to decide on which of the lesions the case under his immediate observation depends.

Causes producing it.

In the second place, when, after the most careful consideration of the symptoms as they actually exist, and of the course which the disease has run previous to the time of examination, the nature of the malady is still doubtful, the practitioner may in some instances be assisted in its determination by the knowledge he obtains of the causes by which it has seemed to be induced.

Effects of remedies.

In the third place, it happens in some cases that the first certainty the practitioner acquires respecting the nature of the disease with which he has to deal, is from the effects of the remedies administered for its removal; whether these effects shall be such as to confirm him in the correctness of the opinion upon which his mode of practice has been founded, or to satisfy him of the error of his diagnosis. It must not be forgotten, however, that inferences of this kind must be subject to the numerous fallacies to which the judgments of medical men, respecting the influence of remedies over diseases, are exposed. Thus, it is well known that medical men long imagined that the most certain test of a syphilitic or non-syphilitic taint in particular cases was to be derived from the fact whether or not the malady disappeared when no mercury was employed; an opinion which recent experience has shown to be wholly without foundation. In modern times Italian physicians have established, as a general law in pathology, a principle, which they designate the law of tolerance of medicines, that would, if well established, render a knowledge of the *juvantia* and *lædentia* a very powerful assistance in forming our diagnosis, and particularly in judging of the intensity of a disease. The principle to which we allude is, that the human body, in becoming diseased, acquires the faculty of supporting medicines suited to its state, in doses exactly proportional to the intensity of the disease; and that it loses this faculty in proportion as the disease diminishes, and in the ratio of its diminution.

It has generally been understood, that when there existed a doubt as to the inflammatory or non-inflammatory character of a disease, a cautious trial of blood-letting might advantageously be made, with a view to throw light on the nature of the disease, and to determine the proper mode of treatment to be pursued. "The effects of remedies carefully considered," says Dr Marshall Hall, "throw an important ray of light upon the nature and force of the disease, and upon the condition and energies of the system." (i. 1.) And in reference to this proposition the author observes, "One of the sources of diagnosis enumerated constitutes a department of knowledge which may be termed *new:* it is that of the effect of remedies, and especially of blood-letting, as a diagnostic of diseases, and as a criterion of the general powers of the system. In cases in which it is doubtful whether the pain or other local affection be the effect of inflammation or of irritation, the question is immediately determined by placing the patient upright, and bleeding to incipient syncope: in inflammation much blood flows; in irritation, very little. The violence of the disease, the powers of the system, and the due measure of the remedy, are determined at the same time. There is, in my opinion," adds Dr Marshall Hall, "no single fact in physic of equal importance and value in the diagnosis of acute diseases and the use of an important remedy." (P. 2, 3.) How far this application of the Italian doctrine of tolerance of medicines to the practice of blood-letting affords a safe rule of practice, we cannot here inquire; but we may observe, that common opinion assigns more influence in the production of syncope from venesection to individual constitution, than to the nature or intensity of the disease for which it is practised.

Impro- ments diagn- resulti from tholog anatom

Lastly, when a case, respecting the exact nature of which any doubt has existed, proves fatal, it is of great importance that the practitioner should have an opportunity of confirming or correcting the judgment he may have formed, by the examination, after death, of the several organs and systems of the body; for though the information then acquired can be of no practical use in the individual case, and the seeking it may, with the ignorant, expose the medical man to Molière's sneer, "d'aviser et voir ce qu'il aurait fallu faire pour guérir un homme qui mourut hier," it may on a future occasion exempt him from doubt, or rescue him from error. It cannot be questioned that a much greater degree of precision than formerly prevailed in medical diagnosis has been introduced, and is in the course of being introduced, into this branch, since medical men have become duly aware of the importance of examining dead bodies for the purpose of determining the existence or non-existence, in particular diseases, of organic alterations of structure, and, when these exist, of ascertaining their nature and seat. But in endeavouring to connect the symptoms that manifest themselves during life, with the morbid alterations of structure found on examination after death, much attention is requisite, as has been already hinted, to enable us to discriminate between those structural changes that give rise to diseases, and those that only develop themselves during their progress, or the existence of which may be merely fortuitous. "Multum prodesse ad intelligendas morborum causas cadaverum sectionem," says Van Swieten in his Commentaries on Boerhaave's Lectures (sect. 1041), "nemo dubitat; interim tamen magnâ cautelâ hic opus est, ne pro morbi causa habeatur illud, quod potius morbi effectus est; multa enim in cadavere inveniuntur mutata per morbum ipsum, quæ non præ-exstiterant ante morbum." To assist us in this discrimination, it is very desirable to have an opportunity of making post-mortem examinations in every stage of the progress of a disease. But in some diseases in which there is no tendency to death, particularly in their early periods, it is only by availing ourselves of deaths accidentally occurring that we are able to ascertain whether the disease depends primarily on organic or structural lesions, and, if so, of what nature these may be.

It would perhaps be impossible to refer to a more happy illustration of the reciprocal light which the attentive examination of the symptoms that present themselves during life, and the careful inspection of the structural lesions met with after death, are calculated to throw upon one another, than is afforded by the connection traced by Dr Bright between a particular affection of the kidney (now well known to medical men under the name of its first accurate describer), and a train of symptoms too often forcing themselves on the attention of the medical practitioner, but which had never before been recognised as depending on a specific pathological condition or proximate cause.

It must, we conceive, be acknowledged upon all hands, that the farther medical inquiries have been pushed, the smaller has the number of diseases become which are not known to be connected with, if not immediately dependent upon, perceptible alterations in the structure of particular portions of the body; or, in other words, that the diseases reputed dynamic have gradually diminished, while those reputed organic or structural have proportionally increased in number. It may be doubted, however, whether medical men, in their anxiety to trace the symptoms of diseases to organic causes, have not occasionally attributed to structural alterations a greater influence in the production of these phenomena than they actually exercise. For, even when structural alterations are found in the organs which, during life, had exhibited symptoms of a deranged condition, it does not necessarily follow that these symptoms and organic alterations were immediately and necessarily connected. In many cases, indeed, the symptoms seem to depend rather on some superadded dynamical derangement, than on the change of texture which has occurred.

In corroboration of this opinion may be mentioned the well-ascertained facts, *first*, that the same organic lesion which in one individual is accompanied with well-marked symptoms, in another individual may give rise to no indication of its existence, which, indeed, may become known only on examination after death; *secondly*, that the same combination of symptoms which *post mortem* examination would lead us to refer in one case to obvious organic alterations, may be found in another case totally unconnected with any perceptible change in the structure of any part of the body; and, *thirdly*, that in some cases of disease in which organic alterations are found after death, the symptoms have exhibited during life a periodical or intermittent character, which could not be the case if they depended simply on organic alterations of structure, seeing that these are not subject to variation. Thus, in a large proportion of epileptic subjects, organic alterations have been met with in the encephalon; but, in the *first* place, it sometimes happens that similar organic alterations are found after death in cases in which no symptoms of epilepsy occurred; in the *second* place, in some cases of epilepsy, no marks of organic disease can be detected; and, in the *third* place, though the organic alterations found in a number of cases of epilepsy may possibly account for such deviations from the healthy exercise of their functions as are manifested by some epileptics *between* their paroxysms, we must suppose that some other morbid condition of the encephalon, not permanent in its existence, but only occasional in its occurrence, is requisite for the production of the paroxysms themselves. "We know," says an intelligent author,[1] "that morbid alterations in the substance of the brain sometimes produce periodic diseases, and that certain additional causes of excitement operating upon an unsound brain, one or other of the functions of that organ is for a time impeded, till the new cause ceases to operate, when the individual immediately returns to his former state of apparent health."

In attempting to distinguish between those diseases which are referrible to an organic pathological condition, and those which are to be considered as dynamical, in the sense that has elsewhere been explained (in the article PATHOLOGY), it is necessary also to keep in mind that a deranged exercise of some, at least, of the functions of the economy, though not originating in any perceptible alteration of structure, may in its continuance give rise to some such alteration. The morbid appearances met with on the examination of dead bodies may, consequently, sometimes stand in the relation of effect to the derangement of function, and the consequent symptoms, of which medical men are disposed to regard them as the cause. "Les troubles des fonctions de la vie," said M. Prost, "et les altérations organiques, sont la double source des maladies, qui s'enchaînent, s'accroissent, et *se reproduisent mutuellement*."[2]

There is another source of fallacy in the attempts made by medical men to refer the symptoms that present themselves during life to such altered appearances as are found after death, in the different textures and organs of the body. We allude to certain changes that are liable to occur during the last periods of life, or even subsequently to death, and which those who are not duly warned of their occurrence, or not aware of the characters by which they may be distinguished, are liable to regard as products of disease. Much has been done, of late years, to facilitate the distinction between truly morbid, and, as they are termed, pseudo-morbid appearances, particularly between those turgescences of the extreme vessels which do, and those which do not, depend on inflammatory action. But, even from the difficulties that have presented themselves in establishing the grounds of distinction between these two sets of appearances, it may be inferred, that when these distinctions were not sufficiently understood or attended to, the symptoms that had manifested themselves during life must not unfrequently have been supposed to find their explanation in altered appearances of different textures and organs, which were not in reality products of morbid action.

From these observations, it is obvious that medical men require to be at all times equally on their guard against attributing to mere dynamical disturbance morbid phenomena which depend upon organic alteration of structure, and against attributing to structural alterations phenomena that arise simply from dynamical derangement. (L.)

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[1] Mackenzie on the Eye, p. 765.

[2] *Médecine Eclairée*, p. liii. See reasons assigned by Dr Abercrombie (on Diseases of the Brain, 3d edit. p. 217) for believing that the affection which has been called *Serous* Apoplexy is to be considered as *Simple* Apoplexy (that is, apoplexy not depending on any perceptible deviation from healthy structure) terminating in effusion.

PHYSICAL GEOGRAPHY.

Physical Geography.

A TREATISE on physical geography should comprehend a description of the general structure of our planet, of the arrangement of the solid and liquid materials of which its surface consists, of the nature of the elastic invisible fluids with which it is surrounded, and an account of the distribution of the organized beings by which it is inhabited. A detailed description of a field so vast, of a range of subjects so multifarious, would embrace every branch of natural history; but the province of physical geography is understood to be limited to general views of the different subjects now indicated. These views, if founded on legitimate deductions from observed phenomena, should enable us to reduce to a few general principles the infinite variety of appearances presented to us by nature; and it is this generalization which in modern times has elevated the study to the dignity of a science. Physical geography, however, in this philosophical sense, is of very recent origin; much of every domain of terrestrial nature yet remains to be explored; the surface of our earth is still but partially known; and although each succeeding age adds prodigiously to the knowledge of mankind, this exhaustless field will, for ages to come, afford materials to exercise the industry and reward the investigations of the philosophical inquirer, ere physical geography approaches to its limits of perfection.

SECT. I.—*Position of the Earth in the System of the Universe; its Form, Magnitude, Density.*

The sublime conceptions of astronomy, founded on observation and on mathematical inductions, have taught us to consider the innumerable stars visible to the naked eye and indicated by the telescope, as so many suns, probably enlightening and gladdening unseen worlds, which revolve round each, as our earth and its kindred planets revolve round our glorious luminary. The stars nearest to our earth are grouped into constellations, for the convenience of descriptive astronomy; but the more distant appear to the eye as nebulous patches or streaks of diluted light, which the highest powers of optical instruments have barely enabled us to resolve partially into clusters of stars, which analogy would lead us to regard as myriads of other suns; while imagination, ranging through illimitable space, pictures still more remote orbs, whose light has for ages travelled the profound, without as yet reaching the abodes of men. Such lofty conceptions of infinite power and beneficence are calculated to elevate the mind which entertains them, and to afford a compensation to human vanity for the comparative insignificance of our earth in the scale of creation. The solar system, of which our planet forms only a small part, seems to be itself but a fragment of a more extended system, round the centre of which the observations of Maskelyne and Herschel have rendered it probable that the sun and the fixed stars all revolve.

The terraqueous globe, without including comets, is one of twenty-nine bodies wheeling round our sun. Of these, eleven are termed *primary planets*, and revolve round the sun as a common centre; the remaining eighteen are named moons, satellites, or secondary planets, because they also revolve round some one of the primaries. The earth is accompanied in her orbit by one of these satellites. The orbits of two other planets are included within her path round the sun. The orbit of the earth is elliptical, but differs so little from a circle, that, in estimating its diameter, it may be considered as such; and its semidiameter, or the earth's distance from the sun, as determined from various astronomical data, especially from the transits of Venus over the sun's disc, equals ninety-five millions of miles.

That the earth is globular, is proved by ships steering in a general direction, either westward or eastward, arriving again at the point of departure; and very satisfactorily by the phenomena exhibited by vessels in receding from an island in the ocean. At a short distance the hull of the ship is sunk below the horizon; a little farther and the *courses* or lower sails are lost; and soon only the upper sails are descried on the circular horizon. The rotundity of the earth is such, that when the eye is elevated six feet above the water, an object on its surface may be seen at a distance of three miles; and at all other altitudes of the eye, the distance of the utmost visible point varies as the square root of the altitude.

Form.

The earth, however, is not a perfect sphere, but is somewhat flattened at the poles, or forms what is termed an *oblate spheroid.* Newton attempted to ascertain the ellipticity of the earth by calculation; and, considering the effect of its diurnal velocity on a homogeneous fluid of the mean density of the earth, he determined its equatorial to be to its polar axis as 236 to 230; but he imagined, that if the density were greater at the centre than at the surface, the compression would be *greater* than in a spheroid of equal density. This error was pointed out by Huygens, who, on the supposition that the density increases regularly with the depth in the earth, estimated the relative axes as 578 to 579. But the determination of both philosophers is at variance with the results of geodesical experiments made about that time, and with the more refined measurements of meridional degrees in different parts of the earth in later times, as well as with the results of observations with the pendulum made by Maskelyne on the mountains of Perthshire, and the very recent investigations on the same subject by Forster, Sabine, Duperrey, Freycinet, Kater, Brisbane, and others.

On comparing the two methods of determining the figure of the earth, we are inclined to place more confidence in the result of measurements of meridional arcs than on the pendulum experiments, because the latter are liable to be disturbed by the geological structure of the regions in which they are made; and this is probably the cause why they accord less with each other than we should have expected from the delicacy of the apparatus, and the expertness of the observers. They give a greater ellipticity to the earth than the comparison of meridional arcs. The latter are not only more accordant with each other, but agree very nearly with the form deduced from the inequalities in the moon's motions, the equations for which were discovered by Laplace. The result of the whole is, that we may safely assume the ellipticity as equal to $\frac{1}{306}$th of the earth's axis; or the polar is to the equatorial diameter as 305 to 306.

Magni and m tions.

The solution of this problem is essential to the determination of the exact length of the radius of the earth; a most important problem in astronomy, as it is the *unit* by which we measure the planetary distances. But the determination of meridional arcs affords the solution of the point in question; and, aided by calculations, we obtain the following results in English miles:

Equatorial radius......................=	3963·7
Polar radius...............................=	3949·8
Ellipticity....................................=	13·9
Mean radius................................=	3956·75
Mean diameter............................=	7913·5
Mean circumference...................=	24871·

The oblate figure of the earth appears to be a consequence of its rotation on its axis. Mathematicians have demonstrated, that if the earth had been a homogeneous body, its ellipticity would have been greater than it really is; and if it had been so constituted that its density increased so as to be infinitely great at the centre, the ellipticity must have been much less. But the ellipticity is intermediate between these extremes, and perhaps coincides with that of a spheroid of equilibrium. The effect of centrifugal motion has evidently affected not only the liquid, but the solid materials of the globe; and this has been adduced by Playfair as a striking proof of the former fluidity of the solid materials of the earth.

The revolution of the earth on its axis is performed in a natural day, or, more strictly speaking, once in $23^h\ 56'\ 4''$; and as its mean circumference is $= 24871$ miles, it follows that any point in its equatorial surface has a rotatory motion of more than 1000 miles per hour. This velocity must gradually diminish to nothing at either pole. Whilst the earth is thus revolving on its axis, it has a progressive motion in its orbit. If we take the length of the earth's orbit at 600,000,000, its motion through space must exceed 68,490 miles in the hour.

Besides these two motions, the refinements of modern astronomy have determined two secular movements of extreme slowness, produced by the attractions of the other heavenly bodies of our system, namely, the motions which cause the *precession of the equinoxes*, and the *nutation of the earth's axis.* These motions, though important astronomical speculations, are little connected with geography; but it is otherwise with the diurnal and annual movements of our planet, the former of which produces the grateful vicissitudes of day and night, the latter the changes of the seasons. Both exercise remarkable influences upon the organized beings inhabiting the earth; and their consequences, therefore, deserve notice in a treatise of physical geography.

Various astronomical phenomena indicate that the density of the earth increases towards the centre. Cavendish endeavoured to estimate the mean density of the earth from the force of gravitation; and, from experiments with spheres of lead, he estimated it at 5·48. The investigations with the pendulum by Maskelyne and more recent observers have given it as equal to 4·71; and perhaps we shall not greatly err, if in round numbers we consider the mean density of the earth as equal to five times that of water. But the average density of the rocky masses which compose the crust of the earth does not exceed 2·5, or 2·8 at the utmost; and therefore the density of the interior parts must be considerably greater than that of the materials on the surface. Laplace considers it as probable that the density increases progressively with the depth, and that the globe may be composed of concentric beds symmetrically arranged round the centre of gravity. From these determinations, some philosophers have conjectured that the interior of the earth must consist of matter as ponderous as the metals, and that probably the metallic veins which we find near the surface may only be small portions of the central masses, expanded and projected through the concentric stony materials by the internal heat of the earth. If, however, we admit that the density of all matter is in the direct ratio of the pressure which it sustains, it has been shown, by a philosopher not less remarkable for the originality and boldness of his theoretical speculations, than for the profundity and sagacity of his philosophical investigations, that the interior of the earth cannot be a solid mass of any material with which we are acquainted, but "that our planet must have a very widely cavernous structure, and that we tread on a crust or shell whose thickness bears but a very small proportion to the diameter of its sphere;"[1] which, since an absolute void is inadmissible, he conjectures to be filled with *elemental heat*, or light in its most concentrated state, shining with the most intense refulgence.

SECT. II.—*General Distribution of the Land and Water.*

On glancing at a map of the world, we are immediately struck with the great extent of its superficies occupied by the waters, which are united into one great *ocean*, filling up the depressions which separate the more elevated portions of the solid crust of the globe, and dividing the land into detached masses of very various extent, which we denominate *continents*, *islands*, or *insulated rocks*. These divisions, however, differ only in size; the continent is but a larger island; and the insulated rock is merely the summit of a mountain, the flanks and base of which are buried below the general level of the sea.

We are in the habit of speaking of the four quarters of the world, and sometimes of its four continents; but it is sufficiently obvious that there are only two great distinct divisions or principal masses of the dry land to which the name of continent should be applied; the eastern, including Europe, Asia, and Africa, which, from being the earliest abodes of civilization, may be termed the *Old Continent;* and the western, or American, which is usually known as the *New Continent.* By confining the designation of continent to these prime divisions of the land, we shall find no difficulty in classing Australia with islands. The old continent includes three of the great divisions of the earth, Europe, Asia, and Africa; the western continent, though chiefly occupied by the descendants of Europeans, is naturally divided into two great portions, which in future ages may become as distinctly marked by political and moral differences as they are by geographical peculiarities.

The vast extent of Australia has induced some geographers to consider it as a continent; but it may more justly be reckoned the first of islands in magnitude; and it might be grouped with the numerous and extensive islands lying to the south-east of the old continent, as a fifth great division of the globe, under the title of the *Oceanic* or *Polynesian.*

The terms employed in describing the various forms of the land, and the subdivisions of the liquid surface of our planet, have been sufficiently noticed under the article GEOGRAPHY, to which the reader is referred.

The slightest glance at a map of the world will show, that there exists a greater accumulation of dry land in the northern than in the southern hemisphere. Recent voyages have indeed proved that this disproportion was over-rated by the geographers of the last age. The late discoveries of the extensive tracts of land to which the names of New Shetland, New Orkney, and Sandwich Land have been given, prove that considerable deductions must be made from what was at one time considered as the domain of the Antarctic Ocean. But the voyages of Cook, Furneaux, Weddell, and others, have shown that these, although extensive groups of islands, do not belong to a great antarctic continent; and even if such existed, the general form of the ancient, as well as of the western continent, towards the north, would still leave a great preponderance of dry land in the northern hemisphere. It is not unworthy of notice, that the proximate sides of the old and new continent seem as if they had mutually influenced the forms of each other; for where any remarkable projection of the one is perceived, we find an indentation nearly opposite in the other. Thus, the principal eastern projection of South America is almost opposite to the vast African *bight*, extending from Cape Palmas to Cape Negro; the great western projection of Africa is opposed to the basin of the Carribbean Sea and the Gulf of Mexico; and the north-eastern trending of the coasts of Europe is balanced by the opposite direction of the shores of North America.

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[1] Leslie's Elements of Natural Philosophy, note I.

Land.

The general disposition of the land is different in each. In the old continent the principal extension is to the west and east; in the new it is to the north and south. In the former we may draw continuous straight lines of immense extent in different directions without encountering one sea. Thus a line from Cape de Verd in Western Africa will pass through continuous land till it reaches the promontory which separates the Yellow Sea from the Gulf of Leatong, a distance of 7800 geographical miles. One projected from Cape Palmas, on the Gulf of Guinea, to the Asiatic promontory called Tschcoutskoi-nos, will extend 8700; and another, from Tangier to the Cape of Good Hope, will be nearly 5800 geographical miles. The longest straight line which we can project on the land of the new continent is from Cumana to Tierra del Fuego, a distance of 4600 geographical miles; and the next, from Icy Cape to Puerto de los Angelos, on the western coast of Mexico, is about 4100. In the old continent the lines we have described have large portions of the surface on either hand; but in the new continent the greater part of the land is on the eastern side of the imaginary lines.

The greatest extension of each considerable division of the two continents lies in the direction of its principal mountain chains. This is strikingly exemplified in America, where the Rocky Mountains and Western Cordillera of Mexico in the northern, and the gigantic Andes in the southern hemisphere, pursue the general direction of the American continent. The greatest extent of Europe is from west to east, and this is the general direction of the chains of the Pyrenees, the Alps, the mountains which form the northern boundary of Turkey in Europe, and the Carpathians. A similar direction is pursued by Mount Taurus, and other ranges of Central Asia, the Himalaya chain, and the mountains of Thibet. In Africa the position of the mountain chains is less known; but the direction of the rivers, and the notices of travellers, would lead to the inference, that, on its eastern side, a spine of mountains, more or less interrupted, extends from Abyssinia towards the southern extremity of Africa. Even the direction of smaller portions of both worlds, as of islands and peninsulas, coincides with their principal mountain chains. This is well illustrated in Norway, in Italy, in the so-called peninsula of India, in Siam, Cambodia, Florida, and California, and on a smaller scale in the islands of Ceylon, Madagascar, Cuba, and Great Britain.

Ocean.

The expanse of the waters is termed the *Ocean;* but, for the convenience of descriptive geography, it is divided into several, though, strictly speaking, there is but one ocean; and the different seas form but parts of a vast whole, which communicate freely with each other, and can scarcely be considered as marked by definite limits. Most geographers speak of two grand oceans, which have derived their appellations from their position relative to the old continent.

I. *The Western Ocean*, which includes three principal subdivisions. 1. The *Northern Ocean*, of which the southern limits are the British coasts, and a line drawn thence to the southern extremity of Greenland. 2. The *Atlantic Ocean*, which should be limited to the south by the extreme projections of Guinea and Brazil. 3. The *Ethiopic Ocean*, which lies between the limits of the last, and a line joining the southern extremities of Africa and America. All three are sometimes, though less correctly, denominated the *Atlantic.*

II. *The Eastern Ocean*, which is also subdivided into three principal portions. 1. *The Indian Ocean*, comprehending the seas between Southern Africa, Australia, and the Malayan Islands. 2. The *Pacific Ocean*, extending from Behring's Straits to Cape Horn, and the southern side of Australia. It is often subdivided into the Northern and Southern Pacific, of which the limits are not well defined. 3. *The Austral* or *Southern Ocean*, which in general terms may be described as extending southwards from a line passing round the globe and touching Van Diemen's Land, and the Cape of Good Hope, and Cape Horn. With these main oceans various seas communicate, either by narrow straits, as the Persian Gulf, the Red Sea, the Mediterranean, and the Baltic; or by wider channels, as the Sea of Okhotsk, the Yellow Sea, the Sea of Hudson, and of Baffin; or by numerous openings, as the Sea of China, the Carribbean Sea, and the Mexican Gulf. The Euxine, the Caspian, the Sea of Aral, and of Baikal, and the magnificent fresh-water lakes of North America, have many of the characteristics of lakes; but their gigantic scale, and their important influence on the climate of the adjacent countries, entitle them to the designation of Inland Seas.

Propo betwe land a water.

The portions of the earth's surface which are covered by the waters bear a large proportion to the dry land. Dr Halley first suggested the idea of ascertaining the comparative surface of the land and water, by cutting them out of a map, and weighing them separately. It was by this means that he ascertained the relative area of the English counties. The astronomy of Dr Long, published in 1742, contains the application of this principle for ascertaining the relative surface of the land and water on the earth. He describes his having cut out each from the gores of Senex's sixteen-inch globes, and on carefully weighing them he obtained the ratio of the water to the land as 349 to 124, or very nearly as 3 to 1. Dr Long's experiment appears to have been conducted with great nicety; for Professor Rigaud of Cambridge has very lately confirmed it by a laborious and careful repetition upon the great scale. This latter gentleman used the gores printed for Addison's three-feet globes, which contain a superficies of 4071½ square inches. The gores of this magnificent globe are twenty-four in number. The torrid zone was divided at these lines and at the equator, and thus formed into forty-eight divisions; the divisions of the two temperate zones were also forty-eight, and these together made ninety-six divisions, each of which was carefully examined separately, divided into land and water, and accurately weighed in a balance which easily indicated one tenth of a grain.

The southern frigid zone was considered as wholly consisting of water; but the northern frigid zone, from longitude 180° to 270° west, was taken as land, and, from 270° to 360°, was computed to consist, one half of land and one half of water. The whole surface of the earth was supposed to be divided into 1000 parts, and all the estimates of the different regions were expressed in proportions of this standard. Rigaud's paper contains several tables, of which the following are the general results.

	Land.	Water.	Ratio.
North polar zone...	18·0263......	23·4437......	100 to 139
North temperate ...	126·6308......	132·5247......	100 ... 105
North half of torrid	52·5582......	146·8162......	100 ... 279
South ditto..........	46·1592......	158·2156......	100 ... 332
South temperate ...	22·5488......	236·6060......	100 ... 1049
South polar..........	... .	41·4700......	... ...
Whole sphere.......	265·9233......	734·0762......	100 ... 276
North hemisphere...	197·2153......	302·7846......	100 ... 154
South hemisphere...	68·7080......	431·2906......	100 ... 628
Whole torrid zone...	98·7171......	300·0318......	100 ... 204

This differs surprisingly little from the estimate of Dr Long, considering that each was deduced from the works of different geographers, and at a considerable interval of time. If we express the ratios of each determination, we shall have, in

Dr Long's estimate, the land to the water......... = 1 : 2·81
Professor Rigaud's.. = 1 : 2·76

And it is also deserving of notice that Rigaud's last estimate differs but little from his former experiment on Carey's twenty-one-inch globe; but both differ considerably from the calculations of Malte-Brun. As, however, that author has not furnished us with the elements of his calculation, it ought not to be put in competition with the elaborate investigations of Long and of Rigaud.

The dry superficies of each great division of the globe was ascertained by the same method; and the tables of Rigaud enable us to give an accurate comparative view of their relative area in thousandths of the earth's surface.

Europe	=15·6989
Asia	=88·7320
Africa	=59·5764
America	=91·2573
New Holland	= 9·9063
Smaller islands	= 0·7524
	265·9233

If we take the whole superficies of the globe=196,836,658 square miles, as the land is to the water in the proportion nearly of 266 to 734 it follows that the whole land occupies a surface of 52,363,231 square miles, and the ocean an area of 144,473,427 square miles.

Sect. III.—*Variations of the Surface.*

Besides the inequality produced by the oblate figure of the earth, different portions of its surface are at different distances from its centre. The dry land is elevated into mountains, depressed into valleys, or stretched out into plains, varying in extent and elevation above the sea; and the ocean itself must be considered as effused into a vast basin, seemingly diversified, like the dry land, with mountains, precipices, valleys, and plateaux of an infinite variety of shapes and dimensions. In fact, the whole dry land may be considered as a series of islands, or of plains and mountains, elevated above the general surface of the ambient fluid which occupies the deeper valleys that divide them.

The whole surface of the dry land is elevated more or less above the general level of the ocean; with one remarkable exception, which, however, has only of late years been detected. Barometrical measurements have shown that a vast area of Central Asia, no less than 18,000 square leagues, is considerably below the level of the ocean. This tract includes the Caspian and the Aral, the surfaces of which have recently been shown to be 101·2 feet lower than that of the Euxine. Should any convulsion of nature, such as earthquakes are known to produce in other quarters of the earth, depress the low sandy tract which now separates the sea of Azof and the Caspian, the waters of the Euxine, and also of the Mediterranean and the Atlantic, would inundate an enormous extent of the sandy *steppes* of Asia, and entirely change the climate and face of that portion of the earth.

Plains of greater or less extent, with inconsiderable inequalities, are found in every region. The most considerable plain in Europe is that which, commencing on the Northern Ocean, between the extremity of Jutland and the mouths of the Scheldt, extends eastwards through Prussia and Poland into Russia, and constitutes in that empire an almost unbroken plain, from the confines of the Frozen Ocean to the shores of the Euxine and the Caspian, until it meets the Uralian chain, which separates Northern Europe from Northern Asia. In this vast expanse, the surface is scarcely broken by any hills, except the inconsiderable ridge of Valdai, between Toropetz, Smolensk, and Moscow, which nowhere rises to 1200 feet above the sea. This magnificent plateau is divided by the Uralian Mountains from a still more extensive plain, which may be denominated the great plain of Northern Asia, the boundaries of which are the Altaian chain and the Icy Ocean. It commences at the eastern side of the Ural, and inclines towards the north-east until it almost touches the Northern Pacific Ocean. Both plains together form a remarkable feature in the surface of our earth, and being only interrupted by the Ural chain, which never exceeds 4500 feet in height, have been regarded by some geographers as but *one plateau;* which, thus considered, is the most extensive on our planet, with a medium breadth of 1100 miles, a length of 6000, and a surface of about 6,600,000 square miles. The surface of much of these two great plains is fertile; some of it is covered with heaths or swamps, producing dwarf birches, willows, and a stunted vegetation; a considerable part is shrouded in dark pine forests.

Far different in appearance are the enormous wastes of arid sand in Northern Africa and Central Asia, the vast *savannas* of the Mississippi and the Missouri, and the *pampas* and *llanos* of South America.

Deserts.

A prodigious zone of sand stretches like an ocean, in Northern Africa, between the ridges of Mount Atlas and the parallels of the Senegal and the Niger, and from the Atlantic to the narrow valley of the Nile. It may be said to cover a tract across that continent between the eighteenth and thirty-first degrees of north latitude, extending from long. 15° W. to 30° E. This enormous area may be considered as having a length of 2470 miles, a breadth of 900 miles, and consequently a superficies of about 2,200,000 square miles. It is, however, by no means an uniform surface of loose sand. In many parts the dreary waste is broken by low hills of naked sandstone, or by tracts of arid clay; occasionally it is enlivened in a few spots by verdant isles, or *oases,* of various extent, according as water finds its way to the parched surface. The principalities of Fezzan and Darfûr are the most considerable of these islands of the desert; but the most celebrated of these insulated spots is the far less considerable oasis of Siwah, the palms of which still wave over the ruins of the Temple of Ammon, and indicate the most ancient seat of African civilization.

Egypt, Nubia, and Sennaar, the eastern boundaries of this desert, would long ago have been overwhelmed by the moving sands of the western desert, but for the annual inundation of the majestic Nile; and thus the empire of sand would have stretched uninterruptedly into Arabia. As it is, the narrow valley of that river, and the Red Sea, are all that separate the African deserts from those of Asia. Soon after quitting the Nile, the traveller by the route of Suez encounters sand, which is continued into the centre of Arabia, where it forms the Desert of Nedsjed, extending to the valley of the Euphrates. The sandy zone then inclines northwards, enters Persia, and forms the saline deserts of Adjemi, Kerman, and Mekran; it is turned north-east by the valley of the Indus, passes through Caubul and Little Bukharia, till it joins the vast deserts of Cobi and Shamo, which occupy so large a portion of Central Asia between the Altaian and Mustag chains, and reach to the confines of China. The sandy zone thus traced throughout the breadth of the ancient continent, from Western Africa to the 120° of east longitude, has been computed to cover an area of 6,500,000 square miles; but the Asiatic portion of this tract includes many chains of mountains and fertile valleys. It is characterized by the occurrence of arid wastes of sand or clay, sometimes with saline incrustations on the surface, and is remarkably deficient in considerable rivers; except the Nile, the Euphrates, the Indus, and the Oxus, there are no large rivers in a region which embraces almost a fourth part of both Africa and Asia. This portion of Central Asia forms a series of elevated plains six thousand miles in length from west to east. "Some of these plains," says Humboldt, "are covered with herbage; others produce only evergreen saliferous plants, with fleshy and jointed stems; but a great number glitter from afar with a saline efflorescence, that crystallizes in the semblance of lichens, and covers the clayey soil with scattered patches like new-fallen snow."

From these elevated plains have issued the barbarous hordes which at different periods have swept like a whirlwind over the regions where the human intellect had achieved its proudest triumphs, and devastated the seats of Asiatic and European civilization. From this *officina gentium* have successively issued the Huns, the Avars, the Mongols, the Alans, and Uzes—the scourges of humanity; and possibly also the tribes by whom the American continent was originally peopled.

North American plains.

The great valley of the Mississippi is a magnificent plain, covered with primeval forests, or spreading in vast savannahs; but a great portion of it is liable to periodical inundations from the river. At 100 miles from the sea its annual inundation has a breadth of from 80 to 100 miles; and even at the mouth of the Ohio, which is 1000 miles from the sea, the inundating waters have the breadth of thirty miles. This shows the extreme flatness of the soil. The river has been extensively embanked, to rescue a portion of the rich soil from these inundations; but, during the season of the inundations, the greatest part of this extensive plain is still abandoned to the alligator and other reptiles, and to enormous herds of wild animals during the rest of the year.

The banks of the Lower Missouri, for 2500 miles, present a succession of fertile plains beyond the reach of inundations. This district, which may be considered as a continuation of the great valley of the Mississippi, exhibits an agreeable intermixture of natural prairies and forests, abounding in wild animals, which retreat before the rapidly-advancing tide of human colonization.

These immense plains are probably destined to become the abodes of a dense population, and perhaps the seat of a mighty empire, subject to few of the natural vicissitudes that impede the march of improvement, if we except the contingent risk of some mighty convulsion, by which the waters of the extensive fresh-water seas of Canada may be permitted to overwhelm this extensive realm with a far more formidable catastrophe than the deluge of Deucalion. Lake Superior has a depth of about 600 feet, and its surface is more than 300 feet above the level of the plains of the Mississippi. Should earthquakes disrupt the intervening barrier, the waters of that and the other great inland seas would sweep these plains with a devastation quite unparalleled in the history of our planet since the deluge of Noah.

South American plains.

The interior of South America presents plains not less extensive, the peculiarities of which have been sketched with a masterly hand by Humboldt. The first may be termed the valley or plain of the Orinoco. It is bounded on the north by the maritime ridge of Caraccas, on the south by the forests of Guiana, and extends westward to the mountain chain of New Granada, the summits of which are lost in perennial snow. It is a solitude of more than 20,000 square leagues.

The second is divided from the first by the mountain-arm which the Andes sends eastward to separate the waters of the Orinoco from those of the Marañon, an interrupted branch, stretching from the towering ridges of Popayan, to the humbler granitic Sierra de Tumucuraque, on the confines of Guiana. The southern boundary of this second plateau consists of the chains of Santa Cruz de la Sierra, of Chiquito, and Cuyaba, which separate it from the plains of the Paraguay, the Parana, and La Plata. The western boundary is the cordillera of the Andes. This territory includes the *llanos*, extended solitudes, with a scanty soil, destitute of trees, but covered with a luxuriant herbage, the consequence of the periodical inundations, which convert this portion of South America into inland seas; amidst the turbid waters of which, as has been forcibly described by Humboldt, may be seen herds of wild cattle and of horses, swimming from one gradually-diminishing island to another, in search of food, or escaping from the attacks of the jaguar, to become the prey of the alligator, or perhaps to be stunned by the strokes of the electric gymnotus. In the immense tract of country included in this second division, are some detached groups of mountains, indicated on the magnificent map of Olmedilla; but they are generally of inconsiderable elevation, and the face of the country may be considered as one enormous plain, or succession of contiguous plains, little elevated above the general level.

The third system of great South American plains forms the basins of the Paraguay and La Plata. This region includes the vast *pampas* of Buenos Ayres, extending from the foot of the eastern ridge of the Andes to the "sea-like Plata," and stretching southward into the cheerless deserts of Patagonia, presenting to the eye interminable plains, with a surface often as unvaried as the ocean, inhabited by vast herds of wild cattle and droves of horses; while the tall form of the *Rhea Americana*, a species of ostrich, frequently gives local peculiarity to the picture.

Table-lands.

Besides the extensive plains already described, which are either not much elevated above the sea, or rise by imperceptible degrees, there are other plains, with steep acclivities on every side, which have thence been termed *table-lands*. Some of these are very extended, and retain a general level of several thousand feet above the sea. Sometimes they are bordered with chains of mountains, much less elevated on the side towards the table-land than in the opposite direction; sometimes they have surfaces much undulated or broken. There are few table-lands in Europe of sufficient importance to be here noticed. The most considerable is that of Central Spain, embracing the two Castilles, which has a general elevation of nearly 2000 feet above the level of the sea. The barometer at Madrid has a mean height of about twenty-seven English inches, which, supposing the instrument on the shores to have a mean of thirty inches, would give to the capital of Spain an elevation of about 1900 English feet. The thermometer in winter often descends below the freezing point; and the *chæmerops* and the *agave*, which flourish luxuriantly in the plains around the table-land, are unknown at that elevation, though under the fortieth parallel of north latitude. The descent from this table-land on all sides is steep; and the transition from the arid and almost treeless plains of Castille, into the milder climate at the foot of the mountain ridges which support it, is marked by the vegetable productions of a warmer latitude.

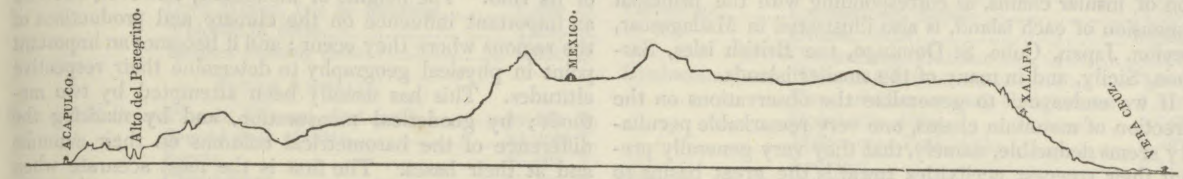
Our imperfect knowledge of Central Asia prevents any accurate notion of the extent and form of these remote regions; but there can be little doubt, that in this quarter there is the most extensive table-land on the face of our globe. The severity of the climate, the direction of the rivers flowing from it on every side, and the scanty information derived from Asiatic caravans, all indicate that there is a prodigious central elevation, supported on the north by the chain of the Altai, on the west by that of Belug Tag, on the south by the mountains of Thibet, and on the east by the chain of Sialki, which divides the country of the Mandshurs from their Tatar brethren of Mongolia. This enormous tract, however, can scarcely be described as consisting of one table-land; for it is intersected by the lofty mountain ranges of Alaki and Mus Tag, which are capped with perennial snows, and it contains the vast, treeless, sandy deserts of Cobi and Shamoo.

The central plateau of Asia, from the severity of its climate, is inferred by Humboldt to have an elevation of not less than 9000 or 10,000 feet above the sea; and this region, including Thibet and the desert of Shamoo, is believed to have a superficies of 1,500,000 square miles.

According to the observations of Olivier, Persia should likewise be considered as a table-land of great elevation. Southern India affords an excellent instance of a table-land, which includes the whole kingdom of Mysore. It stretches from the banks of the Kistna on the north, and is supported by the steep acclivities of the Western, and of the less abrupt Eastern Ghauts. The general elevation of this region is about 3000 feet; but at its southern extremity it abuts against a smaller though much loftier table-land, the district of the Neilgherry Hills, which, till lately, was almost unknown to Europeans. A good account of it has recently been published at Calcutta, by Dr Robert Baikie, from which we learn that the district occupies an area of 600 or 700 square miles, between the eleventh and twelfth degrees of north latitude, and the seventy-sixth and seventy-seventh degrees of east longitude. The general level of its finely-undulated surface is between six and seven thousand feet above the sea. It is connected with the Mysore country by a neck of land about fifteen miles in width; but its northern flank towers above that kingdom by 3500 feet, and it is separated from the subjacent plains of Malabar and Coimbetore by an almost precipitous boundary 7000 feet in perpendicular altitude. The surface is fertile, the climate mild and salubrious; and there the invalid, suffering from the baneful influence of a residence in the sultry plains of India, finds a European climate. The barometer varies from 22·840 to 23·220; whilst the thermometer throughout the year ranges from 73°·51 to 42°, and has a mean of 52°·50. The quantity of rain is = 42·251 inches; heavy rain falls on nineteen days, showers on eighty days, and the clear days are 179 in the year.

The great similarity of this Indian table-land, in elevation, in salubrity, and in climate, to the more extensive table-land of Mexico in North America, is remarkable.

No. 1.



The Mexican plateau (No. 1) has also a general elevation of 7000 feet above the sea; it rises as abruptly as the Neilgherry district, especially from Vera Cruz, and in a single day the European may escape from the pestilential atmosphere of the plains, to an elevation at which the *black vomit* is unknown. The sea-coasts of Mexico are hot and unhealthy at certain seasons, and are known to the natives by the name of *Tierras Calientes*, or burning regions, producing the vegetable riches of the torrid zone. A single day, from Vera Cruz, suffices to reach the height of 4000 feet, where there reigns a perpetual spring; and this region, termed *Tierras Templadas*, though often enveloped in clouds and fogs, is healthy. On ascending to the height of 7000 feet, the traveller gains the *Tierras Frias* of the Mexicans, or great table-land, which has generally a mean temperature of 63° Fahrenheit. It produces the cerealia of Europe, and the vine and the olive flourish on its plains. But its surface is varied by hills; and along its margins, stupendous peaks, such as Orizaba, Popocateptl, and the Sierra Nevada of Mexico, have their summits far above the limits of perpetual snow. There are other plains in Mexico which are more than 1000 feet above the general level of the great plateau. Such is the plain of Toluca, where the climate is severe, and the mean temperature so low that the olive there refuses to ripen its fruit.

Several less extensive table-lands are included between the two lofty parallel chains which constitute the Southern Andes. Thus the plains of Quito and Riobamba are true table-lands; the general level of the first being 8000 feet above the sea, and the city of Riobamba having an elevation of 10,800 feet, so that it is probably the most elevated city in the world.

Mountain chains and ranges of hills are separated by valleys, which have obtained the names of *ravines*, *dells*, *defiles*, or *passes*, when narrow and difficult of access. These chiefly occur among lofty mountains, and sometimes present mural precipices of wonderful sublimity. Narrow valleys often present a striking coincidence in the position of the salient and receding angles of their opposite sides. This has been well described, as observed in the Pyrenees, by Ramond; and some geologists have considered it as a proof that such valleys had been formed by the sudden disruption of continuous strata.

In describing valleys, geologists likewise distinguish them into different kinds, according to their respective relation to the mountain ranges on which they occur. *Principal valleys* are such as run parallel to and separate great chains of mountains. Those which have a direction at a considerable angle with the principal chain, separating the branches or arms of the mountain chain, are termed *lateral valleys;* and the smaller ones, running into these lateral arms, are denominated *subordinate valleys*. The lateral open into the principal, and the subordinate into the lateral valleys.

Sometimes we find a valley, consisting of a chain or succession of basin-shaped cavities, at different levels, separated from each other by narrow gorges. Such appearances are not uncommon among all mountains; and several examples occur in our Highland glens, as in Glen Roy, Glen Gluoy, and Glen Spean, where the fancied parallel roads mark the successive heights at which the waters formerly stood, until the rocky barriers which pent them up were opened.

Sometimes a valley has a circular form, or is *basin-shaped*, and on all hands surrounded with mountains, excepting at a narrow gorge, where the waters of the valley make their escape. Two of the most remarkable instances of this are found in Bohemia and in Cashmere. The former consists of a single circular valley, nearly 200 miles in diameter, which appears at one time to have been a vast lake, until the formation of the defile in the Erzgebirge, through which the Elbe escapes into Saxony. Cashmere is a fertile valley of difficult approach, nearly circular, and ninety miles in diameter, embraced by the arms of the Himalaya Mountains. Native tradition represents it as a lake, until one of the Hindu deities burst the rocky boundary, by the formation of the ravine through which the Vidusta now pours its waters.

Some valleys contain large rivers and lakes, from which there is no issue or outlet. Such valleys have not yet been drained by the giving way of some point of their boundaries. Central Asia affords many instances of this species of valley, as in the districts around the Koko-noi, the Lokenor, the lakes of Zaizan, Kirgha, and Palkati, and the Sea of Aral. A very remarkable instance occurs amidst the loftiest peaks of the Andes, in the valley which contains the great lake of Titicaca, which the ancient Peruvians regarded as sacred, the residence of the founder of their monarchy, and which is sufficiently remarkable, by its extent, and the sublimity of the surrounding scenery.

The most elevated portions of the earth's surface are either connected in extensive mountain chains, or they exist in aggregated groups branching from a common centre, or they form insulated heights, rising more or less abruptly from plains. We have seen that the direction of mountain chains is that of the principal extension of the regions in which they occur; and the same thing holds good in peninsulas and islands, in which we generally find the chains longitudinal. Thus the principal mountains of Europe, Asia, and America form extensive chains in the direction of the greatest extent of each of these divisions of the earth.

The direction of peninsular chains is well seen in Norway, in the Apennines, in the mountains of the western side of Arabia, in the Ghauts of India, and in the mountains of Corea, Kamtschatka, and California. The direction of insular chains, as corresponding with the principal dimension of each island, is also illustrated in Madagascar, Ceylon, Japan, Cuba, St Domingo, the British isles, Sardinia, Sicily, and in many of the smaller islands.

If we endeavour to generalize the observations on the direction of mountain chains, one very remarkable peculiarity seems deducible, namely, that they very generally present their steepest acclivities towards the great basins to which they are contiguous, while they slope more gradually in the opposite direction; and on examining their intimate structure, we find their stratified beds dipping generally *from* the basins to which their escarpments are presented. Thus the ridges of the Scandinavian peninsula present their boldest escarpments to the basin of the Northern Atlantic; while the opposite ranges of Greenland and Iceland also show their steepest acclivities towards that basin. Round the shores of the Mediterranean the same arrangements are especially observable. The lofty ridge of the Atlas is very bold on the northern side, and declines more gradually towards the Sahara. The chain of Spanish mountains which skirt the Mediterranean, from Gibraltar to the Pyrenees, present their escarpments towards that sea; and the Maritime Alps of France, the mountains of Switzerland and the Tyrol, of Istria, Dalmatia, and Thrace, all present their most precipitous sides to the basin of the Mediterranean. We believe that the considerable chain which in Asia Minor extends from Mount Ida to the country around Scanderoon, has the escarpment directed towards the Levant seas; while the mountains of Armenia present their boldest declivities to the basin of the Euxine, and the Caucasus and mountains of Mazanderan towards that of the Caspian. The escarpment of the great chain of Africa, termed that of Lupata, which seems to be prolonged from the lofty mountains of Abyssinia to the south of the Mozambique Channel, would appear, from the little we have learned of its structure, to face the basin of the Indian Ocean; and we know that the steepest declivities of the Western Ghauts of India are directed towards the same basin. The mighty spine of the American continent, from the shores of the Arctic Frozen Ocean to the extremity of South America, through a course of more than 8600 British miles, presents a series of rugged precipices to the vast basin of the Pacific; and, if we might indulge in one sweeping generalization, it would seem that the chains stretching from the Persian Gulf eastward through Thibet, and thence bending to the north-east through Mongolia and Northern China to Tscheoutskoi-nos on the Frozen Ocean, present their fronts also to the Pacific Ocean.

As such coincidences can scarcely be considered as accidental, they afford a wide field for speculation. Can we suppose that appearances, on such an immense scale, have any relation to the operation of the force which caused the elevation of the land, acting towards a central point, and producing the dip of the elevated strata all around, from a common axis of movement? Such speculations, aided by the position of volcanoes, and other mountains of igneous formation, might lead us to infer the direction of the great lines of subterranean disturbances which have modified the appearance of the crust of the earth.

The inequalities of the earth's surface, however considerable they may appear to the eye that contemplates them, bear but a trifling proportion to a sphere of nearly 8000 miles in diameter. The loftiest peaks are not quite five miles in height above the sea; and we may obtain some idea of their effects on its general form, by considering, that such inequalities on the surface of our earth produce no greater proportional deviation from its spherical shape than a roughness equal to $\frac{1}{1600}$th of an inch would on a ball an inch in diameter; not so considerable as the inequalities produced upon the form of an orange by the papillæ of its rind. The heights of mountains, however, exercise an important influence on the climate and productions of the regions where they occur; and it becomes an important point in physical geography to determine their respective altitudes. This has usually been attempted by two methods; by geodesical mensuration, and by marking the difference of the barometrical columns on their summits and at their bases. The first is the most accurate when we can obtain a level base at a moderate distance from the height to be ascertained, and when the measurements of the angles are carefully taken by expert operators, and with good trigonometrical instruments. The use of the barometer is confined to accessible heights; but it is much more easily managed, under such circumstances, and requires little more than attention to the true height of the barometrical column, corrected for the temperature of the instrument and of the ambient air. In variable climates, accuracy would require synchronous observations at the foot and on the summit of the height to be ascertained; but in tropical climates, or even in the south of Europe, the barometer scarcely varies throughout the year at the level of the sea, and therefore such measurements are more easily made. The methods of both kinds of observation are sufficiently detailed in the articles BAROMETRICAL MEASUREMENTS and TRIGONOMETRY.

Accessible heights have also been estimated by the fall of the thermometer on ascending. It has been found that, in our latitudes, an ascent of every 300 feet may be considered as equivalent to a fall of 1° of Fahrenheit's thermometer; but this formula does not answer so well either in high or in low latitudes.

It has also been proposed to measure such elevations by marking the temperature at which water boils at the base and on the summit. A convenient instrument for such observations was invented by the Rev. F. Wollaston, but it is liable to accidents in carriage; and, on the whole, geologists trust either to barometrical or to trigonometrical observations for measuring mountain elevations.

The most lofty mountains in general form parts of extensive chains; but there are many instances of great elevations being attained by isolated peaks. Instances of the former are familiar in the Alps, the Carpathians, the Himalaya, and the Andes; of the latter, in the towering summits of Ætna, Teneriffe, and Mouna Roa in the Sandwich Islands. But such detached elevations are either active or extinct volcanoes.

In the following table we have arranged the heights of mountains, according to the regions in which they occur; and marked the method of determination by the letters B. and T. according as the determination has been made by the barometer or by trigonometrical operations, while E. signifies estimated height.

Physical Geography.

Table of Heights of Mountains, &c.

AFRICA.

Abyssinia	Mountains of Geesh	15,000	E.
	Amid	13,000	E.
	Lamalmon	11,200	E.
	Gondar	8,450	T.
	Taranta	7,800	T.
Morocco	Atlas, two peaks of	11,400	T.
	Abyla or Ape's Hill	3,000?	E.
	Mountains near Fez	10,000?	E.
South Africa	Chain of Lupata	12,000	E.
	Niewveldt, Cape of Good Hope	10,000	E.
	Kom, ditto	5,000	E.
	Khamies, ditto	4,300	E.
	Table Mountains, ditto	3,582	T.
	Devil's Head, ditto	3,315	T.
	Lion's Head, ditto	2,166	T.
African Islands	Teneriffe, the peak	12,236	B.
	Trigo, Canaries	7,400	B.
	Ruivo, Madeira	5,162	T.
	Diana's Peak, St Helena	2,692	T.
	Gros Morne, Isle de Bourbon	9,600	B.
	Volcano in ditto	7,680	B.
	Bonnet Pointu, ditto	6,050	B.

SOUTH AMERICA.

Peru and Bolivia	Pico de Illimani, first peak	24,450	T.
	Second peak of ditto	24,200	T.
	Sorata	25,000	T.
	Chimborazo	21,440	T.
	Antisana, v.	19,150	B.
	Cotopaxi, v.	18,890	B.
	Tunguragua, v.	16,579	B.
	Pichincha, v.	15,940	B.
	Antiquipa, v.	17,800	T.
	Corazon	15,800	T.
	Potosi	16,000	B.
	Defile of Assuay	15,540	B.
	Huancavelica	14,960	T.
	Pass of Quindiu	11,500	B.
	Lake of Titicaca	12,000	B.
	City of Rio Bamba	10,800	B.
	City of Quito	9,356	T.
Columbia	Nevado de Merida	16,420	T.
	Nevado de Sta Martha	15,200	T.
	Volcan de Duida	8,467	T.
	Guadarrama	6,400	T.
	City of Bogota de Sta Fe	8,650	T.
	Mountains of Venezuela	5,000	E.
	Guachano	5,250	B.
	Silla de Caraccas	8,432	T.
	Tumiriquiri	6,250	B.

NORTH AMERICA.

Mexico	Volcan de Popocateptl	17,716	T.
	Pico de Orizaba	17,371	T.
	Nevado de Mexico	15,700	T.
	Nevado de Toluca	15,159	T.
	Coffre de Perote	13,514	T.
	Cerro de Axusco	12,052	B.
	Pico de Tancitaro	10,498	B.
	Volcan de Colima	9,186	B.
	Volcan de Jorullo	4,267	B.
	City of Mexico	7,470	B.
	City of Toluca	8,818	B.
	City of Xalapa	4,333	B.
	Guanaxuato mine	6,836	B.
	Real del Monte mine	9,057	B.
	Valenciana mine	7,637	B.
North-West Coast	Mount St Elias	12,672	T.
	Mount Fairweather	8,970	T.
	Crillon	5,440	T.
East Greenland	Blaaserk	6,000	T.
	Werner Mountains, east coast	6,000	T.
	Coast from 70° 33′ to 71° 12′	3,000	T.
	Church Mountain	2,967	T.
	Double Mount	3,444	T.
	Roscoe Mountains	3,690	T.
	Cape Brewster	4,000	T.
	Raffles's Island	2,000	T.
	Traill Island	1,300	T.
United States	White Mountains, Massachusetts	6,230	B.
	Kaatskill, New York	3,454	B.
	Killington, Vermont	3,450	B.
	Ridge of Alleghany	3,000	B.
	Apalachian Peak	2,700	B.

ASIA.

South Sea Islands	Ophir, Sumatra	13,842	T.
	Volcano in ditto	12,465	T.
	Egmont, New Zealand	11,433	T.
	Volcano, Isle de Bourbon	7,680	T.
	Parmesan, Banka	10,050	T.
	Jesso, Isle of Jesso	7,680	T.
	Quilpaert	6,400	E.
	Mountain in Behring's Isle	6,000	E.
	Mouna Kaah, Sandwich Islands	18,400	E.
	Mouna Roa, ditto	16,020	T.
Himalaya	Dhawala-giri	26,862	T.
	Jamautri	25,500	T.
	Dhaibun	24,740	T.
	Twenty-seven other peaks raised from	15,700	T.
	to	25,669	T.
	Nitee Ghaut	16,814	T.
	Temple of Kedar Nath	12,000	T.
Thibet, &c	Soomoonang, Bootan	14,500	T.
	Ghassa, ditto	13,030	T.
	Chumularee, Thibet	11,960	T.
Hindustan	Western Ghauts	3,500	E.
	Town of Ootacamund, Neilgherries	7,416	B.
	Dodabetta, ditto	8,760	T.
	Morkoortee Peak, ditto	8,402	T.
	Kodanad	6,815	T.
China	Petcha, Chinese Tartary	15,000	E.
	Sochondo, ditto	12,800	E.
	Mountains of Corea	4,480	T.
Asiatic Russia	Italitzkoi, Altai	10,735	T.
	Torgonskoi, ditto	10,700	T.
	Katunayaiskoi, ditto	10,650	T.
	Awatscha, Kamtschatka	9,600	T.
	Sludiua	7,722	T.
	Tangai, Ural	4,912	T.
	Kyria, ditto	3,015	T.
Western Asia	Olympus, Asiatic	6,500	T.
	Ida	4,960	T.
	Ararat	9,500	T.
	Lebanon	9,520	T.
	Gargara	4,960	T.
	Carmel	2,000	E.
	Sinai	5,000	E.
	Elburz in the Caucasus	18,500	T.
	Demavend, in Mazanderan	14,700	B.

EUROPE.

Iceland	Snaefell	6,860	T.
	Hekla	4,900	T.
	Solheima Yökul	5,500	T.
	Oræfa Yökul	6,240	T.
	Akkrefell	2,000	E.
	Hialtadals Yökul	2,000	E.
Norway	Sneehättan	8,115	B.
	Dovrefeldt Range	4,875	B.
	Pass of Jerkin, Dovrefeldt	4,563	B.
	Vorrie, Kiolen, Duder Mountains	3,620	B.
	Akka-Solki, Talvig, ditto	3,392	B.
	Sulitelma	5,910	
Sweden	Areskutan, Jemptland	6,180	B.
	Sylfiœllen	4,020	B.
	Taberg	420	T.
Hanover	Brocken, Hartz	3,690	T.
	Bruchberg	2,800	
Bohemia	Ochsenkopf, Fichtelgebirge	3,980	T.
	Summit of Erzgebirge	3,781	T.
	Donnersberg, Mittlegebirge	2,562	T.
Silesia	Grosse Rader	4,972	T.
	Schneekopf, Riesengebirge	4,950	T.
	Tafelfichte, Riesengebirge	3,781	T.
	Zobtenberg	2,885	T.
Switzerland	Mont Blanc	15,781	T.
	Mont Rosa	15,555	T.
	Jungfrauhorn	13,720	T.
	Schreckhorn	13,397	T.
	Furca	14,040	T.
	Finsteraarhorn	14,116	T.
	L'Allé Blanche	14,775	B.
	Nager Horn	12,217	
	Breithorn	12,800	

	Buet	10,112	
	Mont Cenis	11,460	
	Little St Bernard	9,594	T.
	St Gothard Pass	9,975	
	Simplon	6,463	T.
	Rigi	6,050	T.
	Rossberg	5,154	B.
	Hospice, Great St Bernard	8,040	B.
	Hospice, St Gothard	6,817	B.
Tyrol	Ortler-Spitze	15,430	
	Glockner	13,713	
	Hohenwartshöhe	11,676	
	Orteles	12,859	
	Muschelhorn	10,948	
	Brenner	6,463	T.
Austria	Priel	6,565	B.
	Œtscher	5,990	B.
	Wechsels, Styria	5,352	B.
	Kasberg	5,215	B.
	Gross Kogl, Carinthia	9,700	B.
Hungary	Lomnitz, Peak of Carpathians	8,640	T.
	Peak of Kesmark	8,540	T.
	Gold-mine of Krivan	8,343	T.
Greece	Orbelus	8,500	E.
	Pindus	7,000	E.
	Olympus	6,500	E.
	Parnassus	8,000	E.
	Athos	6,700	T.
	Albanian Mountains	4,000	E.
	Peloponnesian ditto	1,200	E.
	Celene	4,500	B.
	Taygetus	7,200	
Italy	Ætna, Sicily	10,963	T.
	Le Gran Sasso	8,455	T.
	Monte Velino, Naples	8,397	T.
	Monte Chimone	6,401	T.
	Monte de St Angelo, Lipari	5,260	T.
	Vesuvius	3,978	T.
	Soracte	2,271	T.
	Porto Fino, Apennines	1,920	T.
Spain	Gibraltar	1,439	T.
	Mulahacen, Sierra Nevada	11,673	T.
	Pico de Veleta, ditto	11,398	T.
	Sierra Morena	3,000	E.
	Guadarrama	8,500	E.
	Montserrat	3,300	E.
Pyrenees	Mont Perdu	11,283	T.
	Maladetta	10,857	T.
	Le Pic Blanc	10,205	T.
	Tornavacas	8,500	T.
	Canigou	9,290	T.
	Pic d'Abrizon	8,344	T.
France	Louceira, dept. Hautes Alpes	14,451	T.
	Loupilon, ditto	14,144	T.
	Olan-en-Valgodmar, ditto	13,838	T.
	Aiguille Noire, Dauphiné	10,505	T.
	Pic d'Autane, ditto	9,702	T.
	Mont d'Or, Auvergne	6,707	T.
	Puy de Cantal, ditto	6,355	T.
	Puy de Sausi, ditto	6,300	T.
	Puy de Dome	4,750	T.
	Puy de Cleirsou, ditto	4,280	T.
	Puy de Saudoire, ditto	3,980	T.
	Dole, Jura	5,412	B.
England	Helvelyn	3,055	T.
	Skiddaw	3,022	T.
	Saddleback	2,787	T.
	Crossfell	2,901	T.
	Grassmerefell	2,755	T.
	Cheviots	2,658	T.
	Bowfell	2,911	T.
	Conistonfell	2,577	T.
	Ingleborough	2,361	T.
	Hedgehope, Northumberland	2,347	T.
	Whernside	2,334	T.
	Highpike	2,101	T.
	Sneafell, Isle of Man	2,004	T.
	Camfell, York	2,245	T.
	Holmemoss, Derby	1,859	T.
	Brown-Cleehill, Salop	1,805	T.
	Axe Edge, Derby	1,751	T.
	Dundry Hill, Somerset	1,668	T.
	Pendlehill, Lancashire	1,803	T.
	Carraton, Cornwall	1,208	T.
	Malvern	1,414	T.
	Pillar, Cumberland	2,893	T.
	Stowhill, Hereford	1,417	T.
	Wrekin	1,320	T.
Wales	Snowdon	3,571	T.
	Carnedd, Dafydd	3,427	
	Carnedd, Llewellyn	3,467	
	Cader Idris	2,914	
	Arran Fowddy, Merioneth	2,969	
	Arrenig	2,809	
	Caermarthen Van	2,596	
	Cradle Mountain, Brecon	2,545	
	Plinlimmon	2,463	
	Radnor Forest	2,163	
	Llandian	1,898	
	Llangeinor	1,859	
	Moel Fammau	1,845	
	Tregarron Down	1,747	
	Wenmaen Maur	1,540	
Scotland	Ben Macdui	4,418	T.
	Ben Nevis	4,358	T.
	Cairngorm	4,050	
	Ben Wevis	3,720	
	Ben Lawers	3,944	
	Bein More, Assynt	3,903	
	Ben More, Perthshire	3,818	
	Ben Ledi	3,651	
	Schehallien	3,613	
	Bein Deirg	3,550	
	Ben Gloe	3,724	
	Ben Ferkinich	3,482	
	Scairsoch, Aberdeenshire	3,400	
	Ben Aan	3,301	
	Ben Gurdy	3,364	
	Cruachan	3,390	
	Mount Battock, Mearns	3,450	
	Ben Voirlich	3,270	
	Ben Lomond	3,191	
	Stuichachrone	3,171	
	Bein Dearg	3,550	
	Ben Venue	3,000	E.
	Bedinam-brawn	3,150	
	Goatfell, Arran	2,945	T.
	Pap of Jura	2,470	
	Cobbler	2,863	
	Hartfell	2,635	
	Black Larg, Ayrshire	2,890	
	Tintock	2,306	
	Lowther Hill	2,522	
	Eilden Hills	1,300	
	Dollarburn, Peebles	2,840	E.
	Broad Law, ditto	2,800	
	Leadhills, house	1,564	B.
	Caernethan, Edinburghshire	1,700	T.
	Arthur Seat, Edinburgh	810	T.
Ireland	Macgillicuddy's Reeks	3,410	
	Sleibh Dorin, Derry	3,150	
	Croagh-Patrick, Mayo	2,666	
	Morne Hills, Down	2,500	
	Croaghan, Kinshelly	1,850	

From this table it appears that the loftiest pinnacles of our earth are to be found in the Himalaya range. Some of them attain an elevation a mile higher than Chimborazo, which was long regarded as the loftiest mountain on the globe. Of late years our countryman Mr Pentland has measured several mountains in Upper Peru, especially near the Lake of Titicaca, much higher than Chimborazo; and Sorata, one of these, is only surpassed by a few peaks in the great Indian chain. Although those who first attempted to measure the summits of the Himalaya appear to have exaggerated their real altitude, succeeding observers have shown that we must consider that range as the most elevated on the globe, and the peak of Dhawala-giri as the sovereign of mountains.

Human habitations, and even considerable towns, have been erected in very elevated stations on mountain chains. Dr Gerard states, that in the valley of Sulei, in the Himalaya Mountains, there is a village at the enormous elevation of 14,700 feet above the sea, and that rye is cultivated as high as 14,900 feet. Several travellers have found the revered temple of Kedar-Nath to be elevated not less than 12,000 feet. America presents some extraordinary examples of the same kind.

The mines of Potosi	=	16,080 feet.
Town of Potosi	=	13,350 ...
Shepherds' huts on Antisana	=	13,200 ...
Lake and plain of Titicaca	=	12,700 ...
City of Riobamba	=	10,800 ...
City of Quito	=	9,356 ...
City of Toluca, Mexico	=	8,818 ...
City of Mexico	=	7,470 ...

In Europe we have the following.

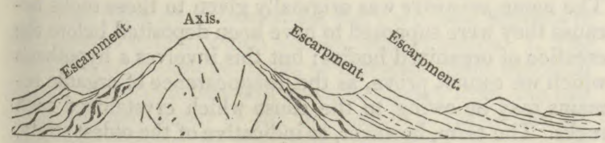
Hospice de St Gothard	=	6,790 ...
Director's house at Leadhills, the highest habitation in Britain	=	1,280 ...

Sect. IV.—*General Arrangement of the Solid Materials of the Globe.*

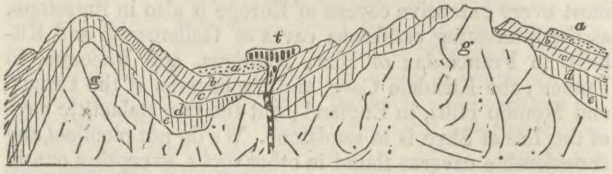
A particular description of the solid materials of our earth has been given under the articles Geology and Mineralogy; but it is our business to present here a brief statement of their general distribution.

Persons unaccustomed to examine the structure of the crust of our earth are apt to imagine that mineral masses present but a confused congeries of stony matter, without any order or particular arrangement. Nothing, however, can be more erroneous. Wherever water-courses, artificial excavations, or abrupt precipices, expose the structure of the crust of the earth, we find very striking appearances of the agency of causes which must have acted with great uniformity over vast portions of its surface, and which have produced a general resemblance between the structure of countries widely distant from each other. A large portion of the solid materials is arranged in beds, varying in extent and thickness, but everywhere indicating the operation of one common agent. These beds are sometimes slightly coherent, as when composed of clay or sand; at other times they are consolidated stony bodies, arranged in parallel layers, which are often subdivided into thinner portions by seams or joints, and preserve their parallelism for a great extent, whether their position be horizontal, or at different degrees of inclination. Such beds are termed *strata*, and the general fact is expressed by the term *stratification.* Sometimes we find a succession of strata of the same rock in juxtaposition; at other times there are strata of different substances interposed or alternating with the principal rock. The position of strata in plains is generally but little inclined towards the horizon; but as we ascend mountains, the strata are usually inclined, sometimes nearly, or even absolutely vertical. When a mountain, or a chain of mountains, is lofty, it is not unusual to find the strata inclined from the centre or axis of the chain towards either hand (No. 2); and in such cases we generally find the strata reposing on a different kind of rock, which has no appearance of having a seamed or stratified structure. Such rocks may also occur in plains; they have frequently a granular or crystalline structure, and form an important class of stony bodies. Hence the distribution of rocks into two great divisions, the stratified and unstratified. Both divisions present instances of rocks which either appear simple or homogeneous to the eye, or consist of stony bodies, which are evidently composed of two or more materials. Instances of the one occur in clay-slate, limestone, quartz-rock, and basalt; of the other in mica-slate, gneiss, granite, and porphyry. The visible axis of a mountain chain is very often some species of unstratified rock, and stratified materials usually form its flanks. In other instances no unstratified material is visible at the axis, as far as we can trace the structure of a mountain. But whenever the mountain is much elevated, or steep, and its sides ploughed by torrents, it is very rare not to find some unstratified material as the nucleus upon which the inclined strata rest (No. 3, *g*). We are not, however, to assume, that in the order of superposition the stratified materials are invariably above the unstratified. Though this holds good in a great number of cases, we frequently observe vast masses of unstratified rock directly resting upon regular strata (No. 3, *t*). In some cases we are able to show such irregular masses connected with other similar materials much lower in the series of rocks, by one or more lines of communication penetrating the strata, which, according to their shape and size, have obtained the name of veins or dykes. Instances of this occur frequently in mountains into the composition of which trap-rocks enter (No. 4).

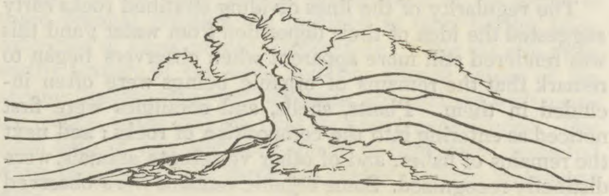
No. 2.



No. 3.



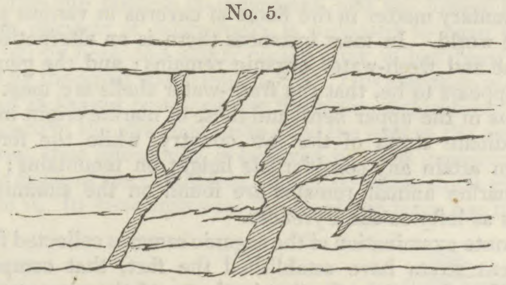
No. 4.



There are, however, other kinds of veins which we cannot so readily trace to larger masses of mineral substances. The most familiar instances of such occur in metallic veins (No. 5). They may often be observed penetrating both stratified and unstratified matter, in the greatest diversity of forms and directions; sometimes in very minute threads, expanding to the dimensions of many feet, or even yards, and repeatedly contracting again to the thickness of a fraction of an inch.

Veins.

No. 5.



Sometimes mineral bodies form irregular masses entirely enclosed in the rocks in which they occur, varying in weight from a few grains to many tons, without any perceptible trace of the mode by which they were so introduced. Occasionally long fissures occur, which are not filled up by any solid material; sometimes also cavities are left in the more solid species of rocks, the sides of which are lined with crystalline bodies of various kinds. Sometimes these fissures and cavities are of enormous extent, forming vast caverns in the bowels of the earth, which are either empty or filled with water. Instances of these on the great scale occur in the limestone strata of many countries, especially of Carniola and North America; and on a less scale in France, Germany, and in our own island. The cavern of Adelsberg, in Carniola, extending to three leagues in its various ramifications, and containing a subterranean lake and river, affords an example of the extent of caverns in limestone rocks; and the no less remarkable Mammoth Cave of Kentucky, which has been traced to the extent of nine or ten miles, is an American example of the same formation. Almost every extensive cavern of Europe is also in limestone, as the interesting ossiferous caves of Gailenreuth and Küloch, in Franconia; of Bize, Somières, and Racogne, in France; the Kirkdale Cave, and the caverns of the Craven and Mendip Hills, in England; but the fine stalactitic cave of the Isle of Skye is in sandstone. We do not recollect any considerable caverns found in other rocks, excepting one in the schist of the island of Thermiæ in the Archipelago, and the vast Icelandic cavern of Surtshellir, in a current of lava which had flowed from the Bald Yökul. This last cavern, as described by Henderson, is nearly a mile in length, and appears to have been formed in the flowing lava by the disengagement of gaseous matters; as it has all the appearance of being the consequence of an enormous air-bubble, having its arched roof ornamented with coralliform projections of black slag. Perhaps we may also give as an exception the small but remarkable columnar cave at Staffa, which is in trap-rock.

Such is the general structure of the solid crust of our earth. But when we examine the rocks more minutely, we find other striking peculiarities belonging to each, which, besides the order of their superposition, mark different eras in their formation.

Basis of Geology.

The regularity of the lines dividing stratified rocks early suggested the idea of their deposition from water; and this was rendered still more apparent when observers began to remark that the remains of organic beings were often included in them. Plants, shells, and corallines were first noticed as entering into the composition of rocks; and next the remains of fishes, and of other vertebrate animals, were distinctly recognized. Some organic remains were observed to pervade limestone rocks at great depths in the earth, and upon very high mountains; and remains of plants, and even stems of trees, were found fossilized, or converted into stone, in the strata of the coal formation. Some remains of marine genera of animals were detected in slaty strata which do not belong to either of these two kinds of rocks; and, lastly, the remains of quadrupeds were recognised in the sandy marl and gypseous deposits which in some countries lie immediately below the soil, or were imbedded in sedimentary matter in the floors of caverns in various parts of the world. In most instances there is an alternation of marine and fresh-water organic remains; and the general fact appears to be, that the fresh-water shells are most numerous in the upper beds, and those of marine origin in the subordinate strata of the low country, while the former seldom attain any considerable height on mountains; but the marine animal remains are found on the summits of ridges as lofty as the Pyrenees.

Minute examination of the organic remains collected from different strata have established the fact, that comparatively but few of the fossil animals are of the same species with those of the same families now living; and we cannot doubt that whole genera and orders have disappeared from the face of the earth. It is only in the upper deposits that any species identical with those now existing have been detected. Where the organic bodies are completely fossilized, very few if any living species can be recognised; and generally the recent species most nearly allied to the fossils are now no longer to be found in the adjacent seas or regions. Thus the fossil-shells and corallines of northern countries, in both continents, have their congeners (when such are known) generally in tropical climates; and the fossil-trees of the British coal-fields have a greater affinity to the *tree-ferns* and *cyacadeæ* of southern regions, than to any sort of European vegetation.

These circumstances are too remarkable not to have suggested theoretical speculations. Accordingly, geology has long been conversant with sublime, but hasty, and sometimes unwarranted generalizations; and though she is still remote from the period when a lasting theory shall safely and satisfactorily embrace the explanation of observed phenomena, yet she has begun to assume a more philosophical aspect. Facts are rapidly accumulating, and the deductions of ingenious men, applying the science of number and calculation to this interesting study, have already established a basis on which future observers may erect a philosophical theory of the earth.

The crystalline arrangements of the particles of a considerable portion of the solid materials of the earth's crust, indicate, beyond doubt, that the particles have been once in a state of such freedom of movement as to assume a determinate order, that is, in a certain degree of fluidity; and hence the geologist assumes that such minerals must have either been softened, or melted by heat, or have been suspended in a fluid medium. The phenomena of stratification, and the incorporation of organized bodies in different rocks, are not less certain indications that a large portion of stony matter has obtained its present form by subsidence from water; and this constitutes the grand basis of geological reasoning. The second link in the chain, the relative age of the different strata, is derived from the order of their succession. As the strata bear the marks of deposition from water, it is obvious that the lowest in the series must have been the first deposited, and the upper beds the most recent formations. No such chronological data are afforded by the unstratified rocks, though their relations to stratified materials afford just inferences respecting their true era; but it is from the examination of the strata of any country that we can arrive at a just conception of its geological history.

Geolo epoch

Relative geological age, then, is to be sought by a careful examination of the superposition of the strata; and as the observation of organic remains has shown a succession of living forms to be peculiar to each series of rocks, the knowledge of such remains forms an important feature in modern geology. Certain fossils are peculiar to certain formations, and we are sometimes able to identify particular rock formations by their included organized remains. It is on such a basis that the most generally received classification of strata has been established; and geologists now usually divide them into three great classes, *the primary*, *secondary*, and *tertiary*.

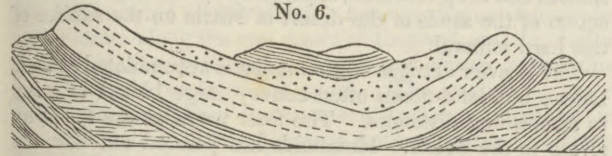
Prima strata.

The primary strata are such as do not include any organic bodies. They are the lowest in the series of strata, and are found to repose on crystalline unstratified rocks, generally on granite, which, as far as we have penetrated the crust, has the appearance of being the general fundamental rock. The name *primitive* was originally given to these rocks because they were supposed to have been deposited before the creation of organized bodies; but this involves a hypothesis which we cannot prove, as the disappearance of organic remains may be owing to the cause which crystallized such rocks. The term, however, as indicative of the oldest strata, is convenient, although the theory which suggested it may be exploded.

Secon strata.

The secondary strata are generally less crystalline in structure, and in their lower beds the organic remains are few, being chiefly marine productions; but these increase in number and variety in the upper beds, which may be said to end with the chalk formation. The organized bodies are chiefly marine productions, as zoophyta, crustacea, shells, fishes; sometimes reptiles, amphibia, and plants are also found in secondary strata. During the deposition of the secondary strata the land appears to have been gradually rising above the level of the waters which once covered it; and during the same period there are marks of more sudden changes or disturbances among them, which are most probably to be accounted for by the forcible irruption of ignigenous rocks from the bowels of the earth. The land appears to have attained extensive elevations above the waters after the deposition of the cretaceous formation, the newest of the secondary rocks; and another system of deposits now begins to be developed. Stratified rocks appear now also to have been formed by deposition from fresh water, as is proved by the abundant remains of animals inhabiting that element; and this is one characteristic of the *tertiary strata.* It is true, that in the coal-fields of the secondary rocks, we occasionally find alternations of sea and fresh water animals; which may be explained by such formations having taken place in extensive estuaries, into which rivers have flowed. But the decided alternations of fresh and salt water deposits are peculiarly characteristic of the tertiary period; and this, with the limitation of such formations to particular basins or circumscribed hollows, enables us to recognise them. Some of the best recognised of these beds are the Paris Basin, the London Basin (No. 6), and that of the Isle of Wight and the opposite coast of Hampshire. Tertiary beds appear to be entirely wanting in Scotland and in Ireland; but they occur in Germany, in Spain, in Italy, and in different parts of Asia and America. In the upper strata of the tertiary period we find many shells similar to living animals in the adjacent seas; and bones of extinct mammalia also occur among their beds. Sometimes the remains belong to genera of which no species now exists; at other times to genera of which we still possess living types.

No. 6.



M. Deshayes has attempted to ascertain the dates of tertiary deposits by the number of living species they contain, considering that which contains the greatest number of existing species the most recent. He distinguishes three tertiary epochs. The most ancient is that of the Paris, London, and Hampshire Basins, in which he finds 3·5 per cent. of living shells, corresponding to the Eocene deposits of Mr Lyell. The middle group includes the basins of the south-west of France, of Baden, Vienna, Hungary, and Moravia. Among these he found 15·2 per cent. of living shells; and this corresponds to Lyell's Miocene period. The most recent strata include the tertiary beds of Italy, Sicily, Spain, of the south-east of France, the Morea, and the *crag* formation of England. In it he detected 45·4 per cent. of living shells; and it corresponds to the Pliocene formation of Mr Lyell.

Besides these great formations, there are local deposits of more limited extent, which we may slightly notice. 1. The formations at present going on, or elevated within historical periods, by earthquakes and volcanic agency from the bed of the sea, and added to the dry land. 2. Lacustrine deposits, now forming the rock called *travertino*, or giving rise to marly sediments. This last deposit, at Big-bone-Lick, in Kentucky, contains bones of the mastodon and other mammalia, with fresh-water shells; and at Market Weighton, in Yorkshire, the bones of the elephant, with those of the lion and the wolf. 3. The incrustations of calcareous matters cementing fragments of other rocks, as in the *nagelfluhe* of the Germans; or including bones of living species, which have fallen or have been washed into caves and fissures. 4. Superficial deposits of gravel and sand, evidently the produce of rivers or of floods, which sometimes contain bones of elephants, the rhinoceros, &c., and are distinguished by the name of diluvian. 5. Erratic blocks of different rocks, which have been removed from their original beds, and scattered over extensive tracts. The most remarkable instances of this transportation are the profusion of large blocks of the zircon syenite of Norway, scattered over all the north of Germany, to the very foot of the Jura chain; of the granites of the Alps on the summit of the Jura, and beyond it into France; and of the granite of Shap Fell, over the intervening mountains, into Lancashire and Yorkshire. 6. The deposits formed by volcanoes at present in activity, consisting either of ashes, mud, or lava; to which we may add the obsidian, pumice beds, trachyte, and basalts of extinct volcanoes. The best characterized and most remarkable of the former are the ashes which have buried Pompeii, the mud eruptions of Tunguragua in 1797, the enormous lava streams of the Skaptàr Yökul in 1783, and of Vesuvius and of Ætna at numerous periods: of the latter, we have examples in the obsidian of Lipari, Ascension Island, and Teneriffe; in the pumice beds of Lipari and of Auvergne; in the trachytes of the latter country, of Germany, and Italy; and in the basalts of almost every region.

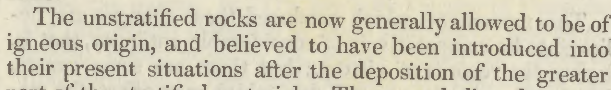
Stratified rocks.

The general opinion now entertained by geologists is, that the stratified materials of the earth's crust have been horizontally deposited from water at different eras, but that the unstratified rocks have been produced by the action of a high temperature. The consolidation of the older strata is supposed to have been accomplished by heat, produced either by internal changes among the elements of which they consist, or derived from a source of heat deep seated in the earth. The less crystalline state of the secondary strata, with the more perfect preservation of the forms of these organic remains, are ascribed to their having been subjected to a less intense temperature; while the still more earthy texture of the beds, and less altered nature of the organic bodies among tertiary strata, are ascribed, with seeming justice, to the still less heat they have experienced. The loose beds of clay and sand appear to have been deposited when the crust of our earth was cooled down to its present state.

Unstratified rocks.

The unstratified rocks are now generally allowed to be of igneous origin, and believed to have been introduced into their present situations after the deposition of the greater part of the stratified materials. These are believed to have been liquefied by heat in the bowels of the earth, and forced upwards by the expansion of elastic matter, either in a softened state, or, in some instances, after they had been melted and again consolidated. In this view, granite, which so often forms the nucleus of mountains, and the lowest basis we can discover of other rocks, is supposed to have been acted on by heat, and slowly cooled after it had been elevated by the agent which liquefied it. This elevation is considered as having produced the fractures, dislocations, and elevations of the stratified rocks; and the heat of the melted material, thus introduced, is believed by most geologists to be the cause of the crystalline state of the older strata which rest on it. In some instances the elevating force has tilted the strata to an absolutely vertical position; at other times it has carried up detached portions of the strata, and separated them from the principal bed, or even inverted the order of their superposition in considerable masses (No. 7). The injection of the fluid matter of granite between some of the strata, has given rise to the rare appearance of beds of this

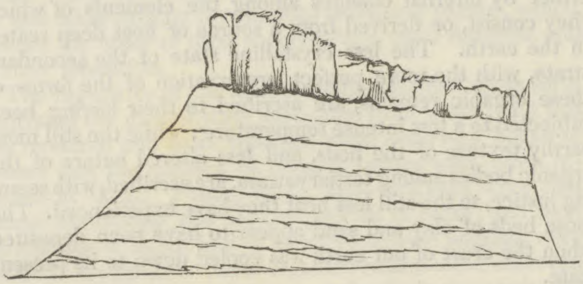
No. 7.



material; and when the force applied has rent or fissured the different strata, some of the liquefied matter has formed granitic veins, penetrating the stratified matter in different directions.

Trap-rocks, in like manner, are now generally considered as the immediate progeny of fire. They are occasionally found as interposed beds, or sometimes alternate with other matter, in distinct but thick beds, though not exhibiting the seams of true stratification. Most geologists regard such appearances as the consequence of subaqueous volcanic eruptions, in which liquid matter had flowed out of craters, spread over the adjacent strata, and been covered by aqueous depositions; after which a repetition of the same process may have given rise to such alternations. The more ordinary appearance of trap-rocks, especially of greenstone and basalt, is either in the form of veins penetrating stratified rocks, or as forming mountain caps, or huge beds superimposed on secondary, or sometimes on tertiary strata. Familiar instances of these veins occur in all coal-fields, more especially in the vicinity of the great coal deposits around Edinburgh and Glasgow. Arthur's Seat, near the former, affords a good example of a mountain capped by trap reposing on sandstone strata; and Salisbury Craig, of a vast bed of greenstone overlying the same strata (No. 8). The chalk of Antrim is in the same manner covered by greenstone and basalt; and the tertiary strata of Auvergne are often concealed by beds of trachyte or other ignigenous rocks.

No. 8.



The movements which produced these changes are believed to be comparatively of considerable antiquity, that is, before the records of history; but there are some causes, in operation at the present day, which may affect the stability of those more ancient arrangements, and which therefore we must now briefly consider.

Sect. V.—*Circumstances affecting the present Order of Geological Phenomena.*

These may be considered as four: Atmospherical action; the effect of the waters of the ocean and of floods; disturbances occasioned by earthquakes; and the influence of volcanoes.

Action of the elements.

1. Atmospherical action is slow, but constant. The united influences of winds and rains serve to form *detritus*, by which the higher portions of the earth's surface are gradually lowered, and the materials thus abraded carried by streams and rivers to the sea. The consequence must be, a very gradual change in the relative level of the land and the ocean. The abrasion of mountains by torrents and impetuous rivers produces deposits of gravel, sand, and mud in plains at their feet. These effects are increased by the sudden bursting of water long pent up in the bowels of a mountain, or dammed up in an alpine lake; thus giving rise to the phenomena which are termed *debacles*. Instances of the fall of mountains have been frequently afforded in the Alps and other lofty mountains. The fall of the Rossberg was foretold by General Pfeffer, several years before it happened, from the existence of enormous collections of water in its bowels; and in the recent fall of one of the *Aiguilles*, which border the southern side of the valley of Chamouni, a vast torrent of liquid mud, bearing before it woods and vast masses of rock, proved the influence which dammed-up water had in the catastrophe. The fall of the mountain of Chiavenna, which in 1618 buried the town of Pleurs and all its inhabitants, appears to have been produced by water insinuating itself among the shaly strata which underlie the limestone beds in the Italian Alps. Among lofty mountains, another cause of disintegration is perpetually at work. The accumulation of snow, and the formation of glaciers on their steep acclivities, where there is a considerable difference between the summer and winter temperature of the climate, is a powerful cause of the degradation of these elevations. The fall of the thundering avalanche, and the movements of the increasing glacier, from its own weight, detach vast masses of rocks, and hurl them into the valleys below. Even the action of minute particles of sand, moved by the winds for a succession of ages, is capable of wearing the hardest stones. Thus the polished surface of the granite of Sinai has been, with great probability, attributed to the perpetual descent of quartz sand over the rock; and we have in our possession nodules of Egyptian jasper, the exterior of which has been worn into smooth and deep channels, apparently by the long-continued action of the sands of the desert of Nitria on the surface of this hard mineral.

The heavier detritus of mountains is accumulated at their bases; but land-floods often convey large blocks of stone to astonishing distances. The finer particles are swept by rivers to the ocean. Humboldt has pointed out how the Gulf of Mexico is rapidly filling up by the sedimentary deposits from the waters of the Mississippi and other rivers which fall into that inland sea. The turbid waters of the Orinoco and the Marañon discolour the ocean to the distance of 300 miles from their mouths; and there can be no doubt that the formation of the flat land of Guiana, now about 100 miles in width, from the most eastern ridge of hills, is principally the alluvial deposition of these mighty rivers. The waters of the Ganges, at the highest inundation, are stated by Rennell to contain an enormous quantity of sedimentary matter; and we can hence conceive how the flat shores of the Hoogly, and the other branches, have originally been formed, and how the Bay of Bengal may, in process of time, be materially altered in its depth. Another striking instance of the effect of rivers in *silting* up a confined sea is to be observed in the Gulf of Leaotong, or upper part of the Yellow Sea, into which a great part of the detritus of Northern China is deposited by its numerous large rivers, and by the effects of the strong currents in that inland sea. Staunton has calculated that the Yellow River alone discharges into the Yellow Sea more than 2,000,000 of cubic feet of earthy matter every hour. The matter carried down by the Nile and the Po is well known to affect the extent and deepness of the adjacent seas; and the distance of Ravenna from the present shores of the Mediterranean (between three and four miles) proves how a comparatively small river like the Montone, pouring its sediment into a still bay, has altered the situation of a port, where, in the ages even of the lower empire, the Roman fleets used to anchor. These facts would lead to the supposition that the land was gaining upon the sea; but there are other circumstances which are at least equivalent to this change.

The natural consequence, as was well pointed out by Playfair in his Illustrations of the Huttonian Theory, and previously noticed by Manfredi, must be to elevate the surface of the ocean, by the deposits of detritus in its bed. This rise is most conspicuous in inland seas. Thus, on the western side of Italy, the ruins of the palace of Tiberius at Capræ are now wholly covered by the sea; and the far-famed temple of Serapis, situated on the Bay of Baiæ, has its pavement below the present level of the Mediterranean. Manfredi states, that when the ancient pavement of the cathedral of Ravenna was discovered in 1731, it was found to be a foot below the present high-water mark; from which we must infer that the level of the Adriatic had risen at least as much in 1500 years. The shores of Baiæ may have had the level altered by the vicinity of an active volcano, and the temple alluded to shows indications of more than one upheaving and depression of the land; but the district of Ravenna is all alluvial; and a similar rising was noticed at Venice by Zendrini.

The same fact is attested by observations along our own coasts. The submarine forest on the coast of Lincoln, first described by Correa de Serra in the Philosophical Transactions, 1799, proves a rise in the level of the sea; and the tradition, that the Godwin Sands once formed part of the fertile domain of the Saxon earl of that name, has probably a fair claim to be arranged with the same phenomenon.

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2. The wasting of the land by the waves of the ocean, and the overwhelming of large tracts by the sea, are nearly allied facts. The changes on our own coasts, and on the countries between the Rhine and the Elbe, afford striking instances of the encroachments of the ocean on the land. Even where the rocky boundaries are the most solid, the ceaseless action of the waves has wasted and disintegrated the cliffs around all our shores; but the destruction of the softer strata along the east coasts of England, and the chalky heights of Dover, is still going on, and affords undeniable proofs of the power of this agent. The swallowing up of whole districts along the coasts of Yorkshire is shown in the annihilation of the villages of Auburn, Hyde, and Hartburn, and in the ravages of the sea on the neck of land uniting the Spurnhead with the rest of the country. We have authentic records of the destruction of Dunwich, on the coast of Suffolk; and near Harwich, in Essex, the sea is annually encroaching. The Start islet was within the memory of man a part of the island of Sandey, in the Orkneys.

Still more remarkable changes have taken place on the coasts of Holland and Friesland within historical periods. Well-known instances of this occurred in the devastation which accompanied the formation of the Zuyder Zee in the beginning of the thirteenth century; in the successive encroachments of the ocean, which formed the islands near the Texel in 1251; and in the disappearance of the once fertile district of North Friesland, the only remnants of which, since the disastrous 11th of October 1634, are the three small islets of Noordstrand.

Such changes have occurred in various parts of the earth. Some of them, especially the overwhelming of low sea-coasts, may be owing to the gradual elevation of the level of the sea by detritus washed into it; but probably still more is due to changes in the level of the land by unequal subsidence, the consequence of earthquakes.

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3. The terrible effects of earthquakes have attracted attention in every age, and records of some of such convulsions have descended to us from very remote ages. No period of our earth's history has been more noted for the violence and extent of earthquakes than that between the first, third, and the middle of the fourteenth century. China was terribly convulsed for ten years from 1333, when Kiang-si, its capital, was swallowed up; mountains were engulfed, and floods, occasioned by the obstruction of the course of rivers, destroyed vast multitudes of human beings. The succussions extended westwards, and Asia Minor and Egypt were violently shaken in 1346; while in the following year severe earthquakes were experienced in Cyprus, Greece, and Italy. In 1692, the island of Jamaica was visited by a most terrible earthquake, in which enormous masses of earth and rock were detached from the Blue Mountains, and vast quantities of timber, hurled from their flanks, covered the adjacent sea like floating islands. It was during this earthquake that the city of Port Royal, with a tract of adjacent land, estimated at 1000 acres, sunk, in one minute, into the deep. In the succeeding year great earthquakes in Sicily destroyed the city of Catania, and a hundred and forty other towns and villages in that island, where upwards of 100,000 persons perished. In 1746, Lower Peru suffered severely from this calamity. The ocean burst in upon the land with irresistible force, when the barrier of land sunk into the sea, Lima was overwhelmed, and the present port of Callao formed. These convulsions were accompanied by eruptions of water and mud from several volcanoes among the Andes. In 1750, the city of Conception, in Chili, disappeared during an earthquake, and the sea rolled over it. In 1755, Lisbon was in a great measure destroyed by one of the most terrible earthquakes that ever visited Europe. The mountain chains between the Douro and the Tagus were most dreadfully convulsed. The new mole at Lisbon, to which multitudes had fled, as to a place of safety, suddenly sunk into an hideous abyss, and not one body floated to the surface, nor were any fragments of the vessels sucked into the chasm rendered up, and on the spot there is now an hundred fathoms of water. In this awful convulsion at Lisbon sixty thousand persons perished in about six minutes. A violent shock threw down the greatest part of the city, and the sea retired, leaving the bar momentarily dry; but suddenly a mighty wave, fifty feet high, rolled in on the devoted city. The extent of the *terræ motus*, on this occasion, is very remarkable. The violence of the shocks, which were accompanied by a fearful subterranean noise, like the loudest thunder, was chiefly felt in Portugal, Spain, and Northern Africa; but its effects were perceived over a considerable part of Europe, and were even experienced in the West Indies. Our Scottish lakes, particularly Loch Ness and Loch Lomond, rose and fell repeatedly on that dreadful day. Ships at sea were affected by the shocks, as if they had struck on rocks, and their crews were in some instances thrown down by the violence of the concussions. In 1766, the island of Trinidad, and great part of Colombia, were violently agitated by earthquakes; an islet in the Orinoco disappeared, and land in other parts of the coast was raised above the waters. In 1772, the lofty volcano of Papandayang (the loftiest mountain in Java) disappeared, and an area around, fifteen miles by six, was swallowed up. Most terrible earthquakes desolated Calabria in 1783. This calamity has been admirably described by several writers, among whom we may mention Dr Vivenzio, Grimaldi, Sir William Hamilton, Dolomieu, and the commission of the Royal Academy of Naples. The violence of the shocks was chiefly felt in the Farther Calabria, and in the neighbourhood of Messina. The principal agitation was felt over an area of five hundred square miles. Many sudden sinkings of the land were perceived, numerous fissures were formed, and partial elevations were effected in some places. The greatest depressions happened at Terra Nuova, Oppido, Sinopoli, and Santa Christina: a fissure a mile in length, a hundred and five feet in width, and thirty feet in depth, opened at Plaisano; another about the same length, and a hundred feet in depth, was formed at Cerzulle; and at La Fortuna a chasm a quarter of a mile in length, thirty feet in width, and two hundred and twenty-five feet in depth, suddenly opened in the ground. In some districts considerable mountain-slips, or the separation of huge masses of earth and rock, took place; and along the Straits of Messina, in the neighbourhood of Scylla, the cliff of Gian-Greco, a mile in length, was precipitated on the subjacent houses and gardens. A fragment detached by the earthquake from Monte Jaci crushed multitudes who had fled to the shore for safety; and at the same moment a wave broke on the devoted shore, and swept away the aged prince of Scylla, and numbers of his people.

In the year 1797, Upper Peru was terribly convulsed. The shocks of earthquakes continued with great violence for three months, and the face of the country in the centre of the convulsion was totally changed. In 1811, violent earthquakes shook the valley of the Mississippi, by which lakes of considerable extent disappeared, and new ones were formed; but these were less terrific than the catastrophe which destroyed the city of Caraccas in 1812. On the 26th of March there were heard subterraneous thunderings; the ground undulated, as if agitated by a boiling liquid, and at one shock this fine city entombed in its ruins 10,000 of its inhabitants. During the earthquake the great lake of Maracaibo had its level lowered, and the riven earth at Puerto Cabello and Valencia poured forth enormous torrents of water. It is remarkable, that the volcano of St Vincent, which had been perfectly quiescent for a century, burst out with prodigious violence on the 27th of April in the same year, and threw out clouds of ashes, which rose to an immense height into the air. Much of the island was ruined by showers of scoriæ and ashes; and such was the violence of the eruption, that the decks of vessels 200 miles to windward of St Vincent were covered with an impalpable dust. On the day of this eruption subterranean thunderings were distinctly heard at Caraccas, and even on the Rio Apure, 210 leagues in a right line from St Vincent. In the eruption of Tomboro, about to be noticed, the earthquakes extended throughout an area a thousand miles in diameter, a considerable tract of land at the foot of the mountain disappeared in the waves, and the port of Bima, where ships of war could formerly anchor, was ruined by the upraising of a shoal. On the 19th of November 1822, Chili was visited by a most destructive earthquake. The shock was strongly felt at the same time throughout a line of coast 1200 miles in extent. It is stated, on good authority, that the coast for one hundred miles sustained an elevation of from two to four feet; and about a mile inland from Valparaiso it was raised from six to seven feet. The sudden elevation of the coast was indicated by shell-fish being found adherent to the rocks considerably above high-water mark. The shocks continued until the end of September in the following year; and the area over which the permanent alteration of level extended is believed to embrace the country from the base of the Andes to the sea, a surface of not less than 100,000 square miles. In 1827 Popayan and Bogota suffered most severely from earthquakes, during which vast fissures opened in the elevated plains around the latter city.

The last earthquake in Europe occurred in Murcia in 1829, near Alicante. Several villages in an area of above four square miles were thrown down by vertical movements in the valley through which the Rio Segura flows, and many small fissures were formed in the alluvial soil; while black mud, sand, and marine shells were thrown up from small cavities formed near the sea. Such are some of the severer earthquakes on record; but less considerable shocks are of frequent occurrence in various countries, especially in South America and in Italy. Smart shocks are occasionally felt in Scotland. They have often occurred at Comrie in Perthshire. A smart shock rent the spire on the town-hall of Inverness in the year 1816; and another earthquake was felt at Lancaster in 1834, which shattered chimneys, and alarmed the inhabitants. But all the shocks experienced in our island have fortunately been insignificant compared to those which have been felt in many other countries.

Action of volcanoes.

4. The alterations produced on our earth's surface by volcanoes in activity within historical periods appear to be underrated by some writers. Few geologists now will be disposed to doubt that most of the phenomena of earthquakes are the consequences of volcanic fire. The coincidence of those formidable shakings of the earth with volcanic eruptions, and the distance to which such agitations have been felt, show that the causes of both are deep-seated in the earth, and that they are probably the consequences of elastic matter formed by subterranean heat. We shall say nothing of the almost universal diffusion of trap-rocks, which, under the name of trachyte, basalt, greenstone, and trap-tuffa, are now generally admitted to be of igneous origin, nor of the true craters of extinct volcanoes which abound in France, Germany, and many other parts of the earth, but which have ceased to emit any eruption within known periods, and confine our attention to those mountains now either in active combustion, or which have been so within historical periods. Gay-Lussac enumerates 163 volcanoes active at the present time; and Professor Jameson gives the following distribution of 193 volcanoes in a state of present activity:

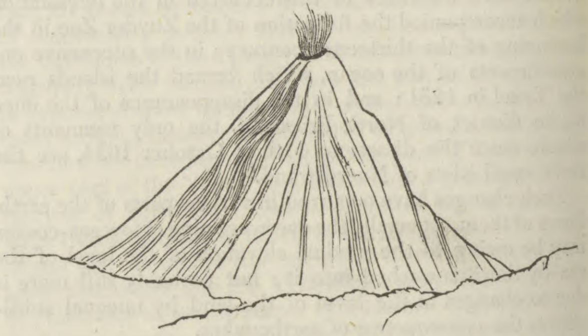
Continent of Europe	1	Continent of Amcrica	87
European islands	12	American islands	19
Continent of Asia	8		
Asiatic isles	58		193
African islands	8		

To these we may add the gigantic crater of Kirauea, in Hawaiah, one of the Sandwich Islands; the volcano of Tomboro, in the isle of Sumbawa; the volcano of Tofua, in the Friendly Islands; that of Barren Island, one of the Andamans, in the Bay of Bengal; to which we may perhaps add the submarine volcanoes which have suddenly risen from the bosom of the deep, but soon afterwards have again disappeared, as that of Nyoë, off the coast of Iceland; Sabrina, off St Michaels, in the Azores; and Graham's Island, not far from the east coast of Sicily.

The substances ejected by volcanoes consist either of melted stony matter termed *lava*, of *scoriæ*, of ashes, of sand, of muddy eruptions, or of vast quantities of hot and fetid water, always accompanied by earthquakes and subterranean thunderings, and generally by columns of flame or of dense smoke.

The general form of a volcano is a truncated cone, often isolated, and having a circular depression or spiracle on or near its summit, which is named a *crater*. From this crater smoke is perpetually issuing; sometimes flame appears, or volleys of ignited stones are projected into the air. From the dark cloud of smoke emitted during eruptions, vivid lightnings are usually seen to dart; and the vapours of sulphur, ammonia, or of muriatic acid, are often emitted. Sometimes the boiling lava is elevated from the bowels of the mountain to its terminal crater, fills that cavity entirely, and descends from the cone in streams of liquid fire, which concretes as it cools on the surface, but continues to move on with resistless force till it congeals into stone, though it often retains its heat for long periods. At other times the elasticity of the pent-up matter is incapable of forcing the lava to the highest crater; but the liquefied material bursts through the flanks of the mountain, and pours into the plains. Sometimes the volcanic cone is included in an exterior one; a circumstance on which Von Buch has founded his theory of *craters of elevation* (No. 10). The strata or beds in both concs are inclined from the general axis. The projectile power of volcanoes is prodigious. The dust of the volcano of St Vincent was carried more than 200 miles

No. 9.



No. 10.

eastward of that island, and must have attained a vast elevation, to obviate the effect of the trade-wind in its descent. It is stated, on credible authority, that Vesuvius has projected large stones 3600 feet above its summit; and Cotopaxi was ascertained by the French academicians to have hurled a rock, calculated to weigh 200 tons, to the distance of three leagues, or more than ten English miles.

Instances of volcanic eruptions are by no means rare. There are fifty-nine or sixty eruptions of Ætna recorded by historians, and about fifty-two of Vesuvius. The first eruptions of Ætna are lost in the remoteness of antiquity. Vesuvius was not in existence as an active volcano till the year seventy-nine of the Christian era, when the ancient crater presented a slight circular hollow, the sides of which were overgrown with wild vines, and the exterior of the cone was well cultivated. In the eruption which then took place, Stabiæ, Herculanum, and Pompeii were destroyed, and the elder Pliny lost his life. Stromboli appears to have been an active volcano from 300 years before Christ, and is still in a state of incessant activity, ejecting flame and red-hot stones in quick succession. The most noted eruption of Ætna was probably that of 1699, when, from a long rent on its flank, it poured out a stream of lava, which in its course to the sea destroyed fourteen towns and villages, some of which contained three or four thousand inhabitants. This current is fifteen miles in length, about 600 yards at its broadest part, and there it is forty feet deep. Vesuvius has more frequently been active in our own times than Ætna. One of its most terrible eruptions was that of 1538, when Monte Nuovo was forced up in two days to the height of 413 feet, and with a circumference of 8000 feet. Another happened in 1631, which covered with lava most of the villages at its foot, and sent forth torrents of boiling water. In little more than a century it has had eighteen eruptions. The eruption of 1794 has been well described by Breislac, who estimates one of its streams of lava on that occasion as containing upwards of forty-six millions of cubic feet. It again burned with great fury in 1805, 1813, and in 1822. We possess lavas of this latter period so strongly impregnated with sulphuric and muriatic acids, that they destroy every species of vegetable material they rest on; and, when recent, the specimens smelled strong of the latter acid. The volcanoes of Iceland have been in activity ever since the island was discovered, in the ninth century. Hekla, though not the most considerable of these, from its position and its former activity, is the best known. It has had many formidable eruptions, twenty-two of which have been noted in about 800 years; and in the same period we have notices of twenty eruptions from five other Icelandic volcanoes. A succession of eruptions of Hekla lasted for six years; but the most severe convulsions of that country happened in 1783, when the dreadful eruption of the Skaptàr Yökul burst forth, and did not cease till the following year. About a month before this terrible catastrophe a submarine volcano elevated the crater of Nyoë, seventy miles south-west of Cape Reikianes, and threw out such an immense quantity of scoriæ as to cover the sea, to the distance of 150 miles, with a stream which impeded the progress of ships making the island; and portions of this eruption floated as far as the Shetland and Orkney Islands. Nyoë emitted smoke and scoriæ from several apertures; but within a year the island disappeared, and a shoal marks its former site. On the 8th of June the Skaptàr Yökul threw out smoke; on the 10th an enormous current of molten lava flowed from numerous cones on the Yökul, which, dividing into two main streams, pursued its course to the sea, filling up the beds of two large rivers, and covering an immense extent of once productive country. The horrors of the scene were aggravated by the enormous torrents of boiling water produced by the liquefaction of the glaciers that covered the Yökul, and by incessant showers of ashes which darkened the sun; stream of lava succeeded stream from the 10th of June to the end of August, at short intervals; and noxious emanations destroyed numbers of those whom fire and water had spared. From this calamity Iceland has never recovered; for within the space of two years the island, in consequence of this eruption, lost 9336 persons, 11,460 head of cattle, 28,000 horses, and 190,480 sheep. The extent of the principal stream of lava is fifty miles in length; its greatest breadth is from twelve to fifteen miles; in the plains its general depth is 100 feet, but in the channel of the Skaptà River, which it dried up, it is 600 feet in perpendicular depth. The south-western side of Iceland appears to be one vast focus of subterranean fire; for the several eruptions of the Oræfa, the Skeiderà, Sida, and Skaptàr Yökuls, seem but as occasional *outbreakings* from one immense volcanic fissure, which really belongs to the same chain of icy mountains.

Volcanoes of Eastern Islands.

The volcanic formations of Java have been well examined by Dr Horsfield, who describes them as extending throughout the centre of that noble island. They form a chain, in which thirty-eight large mountains, evidently volcanic, are conspicuous, and attain an elevation of from 5000 to 12,000 feet. Most of them are no longer in activity. Tankuban Prahu has been quiescent for a series of ages; but its crater contains a large lake, a mile and a half in circumference, and 250 feet deep, from one side of which sulphureous vapour issues with great violence. Papandayang was once the largest of the Javan volcanoes; but in August 1772 the greatest part of it was swallowed up during an eruption. A luminous cloud at first seemed to envelope the mountain, prodigious quantities of ashes were ejected, which destroyed forty villages, and an area of fifteen miles by six was entirely swallowed up.

The eruption of Tomboro, in the island of Sumbawa, in the year 1815, described by Sir Stamford Raffles, is one of the most violent on record. The earthquakes caused by this eruption were felt over a circle with a radius of 1000 miles; and all around to the distance of 300 miles the quantity of ashes excited terror and dismay. In Java, though 300 miles in a direct line from Sumbawa, the sky at mid-day was darkened by dense clouds of fine dust ejected from the volcano. In Sumbawa it was attended by a whirlwind of surprising fury, which lasted for an hour, sweeping away trees and houses in its career. The explosions commenced on the ceasing of the whirlwind. They began on the 5th of April, and continued until the 15th of July. Whole villages were swept away, and upwards of 12,000 persons perished in this eruption. Vast numbers of trees, torn up by the whirlwind, strewed the ocean to a considerable extent. Raffles states that the explosions of Tomboro were distinctly heard in a circle with a diameter of 1700 miles; and that the quantity of light scoriæ and pumice it threw out within a week formed a bed on the ocean two feet in thickness, and many miles in extent, which impeded ships in approaching Sumatra.

Volcanoes of South America.

The volcanoes of America claim notice, not only from their magnitude and number, but from the peculiarities of their position. Several of the most lofty mountains of the South American Andes are active volcanoes. Cotopaxi has an elevation of 16,800 feet above the sea; the volcanoes of Mecas and Antisana equal 17,000 feet, and Tunguragua 16,500 feet. Humboldt considers these enormous cones as the spiracles of one prodigious volcanic vault, stretching from south to north, which presents an area of 600 square leagues; and he regards them as merely different summits of the same volcanic mass. "The fire issues sometimes from one, sometimes from another, of these summits. The obstructed craters appear to us to be extinguished volcanoes; but we may presume, that while Cotopaxi or Tunguragua have only one or two eruptions in the course of a century, the fire is not less active under the city of Quito, under Pichincha, and Imbaburu."

The connection of the volcano of Pasto, in New Granada, with the volcanoes of Quito, was strikingly displayed in 1797. A column of black smoke had continued for several months to issue from the Volcan de Pasto; but, to the surprise of the inhabitants, this smoke suddenly disappeared on the 4th of February 1797, at the precise moment when, at sixty-five leagues from the city of Pasto, the city of Riobamba, near Tunguragua, was destroyed by a terrific earthquake.

The eruption of Tunguragua, on the 4th of February 1797, was of a very extraordinary nature. The country around, to the extent of forty leagues from south to north and twenty leagues from east to west, sustained an undulatory movement of extreme violence, which lasted four minutes. In the district around the mountain every town was levelled with the ground, and the cities of Riobamba and Quero were buried under the ruins of the impending mountains. The base of Tunguragua was riven asunder, and poured out, from numerous apertures, streams of water and mud, which accumulated in the valleys to 600 feet in depth. The mud covered everything, blocked up the channels of the rivers, forming lakes which remained for more than eighty days. Fetid, suffocating exhalations were emitted by the lake Quilotoa, and it is said that flames also issued. The covering of mud, and the levelling of elevated portions of the country, totally changed its face. The shocks continued to be violent for upwards of three months, and were felt over a district 170 leagues from south to north, and 140 from west to east. It was during this eruption that the curious fishes, *Pimelodes Cyclopum*, were discovered in the ejected water of the volcano. They are supposed to be generated in subterranean lakes in the bowels of the mountain, and only to be brought to light by such an explosion. There are no less than sixteen active volcanoes in Chili, the eruptions of which are confined to the valleys of the Andes. A line of volcanoes in South America may be distinctly traced from 5° to 6° of south latitude, running parallel to the ocean, and occupying the highest ridges of the Andes.

Volcanoes of North America.

In North America, Mexico presents a chain of active volcanoes crossing the general direction of the cordillera of Anahuac from east to west. It commences on the coasts of the Mexican Gulf, with the small but energetic Volcan de Tuxtla, which lies a little to the southward of a line joining the rest; next is the vast cone of the peak of Orizaba (No. 9), which attains an elevation of 16,365 feet; and then the still loftier Popocateptl, rising to 17,060 feet. These lie to the east of the city of Mexico; and on its west are the cones of Jorullo and Colima. They are all active; but at no very distant period the snow-clad summits of Iztaccihuatl, of Toluca, and of Tancitara, lying in the same line, were also burning. This chain extends for 140 leagues; and perhaps the volcanoes should be considered as spiracles, all connected with an huge ignited fissure, passing throughout the table-land of Mexico. Five of these mountains penetrate far into the region of perpetual congelation; and from the inaccessible summits of Orizaba and Popocateptl are pinnacles of frozen snow, from which smoke continually issues.

The extent of these eruptions is attested by the prevalence of volcanic rocks over the whole table-land; and the present form of this magnificent plateau would seem to be derived from the accumulation of ignigenous formations in a series of valleys among primary rocks. Tuxtla had a strong eruption in 1793, which covered the roofs of the houses at Oaxaca, Vera Cruz, and Perote, with ashes; and at the latter, which is 196 miles distant, the subterranean noises resembled heavy discharges of artillery.

The formation of the volcano of Jorullo dates not farther back than the year 1759. Until that period, the present site of the volcano was a fertile plain, well cultivated, and producing indigo and the sugar-cane. In the month of June in 1759 subterranean thunderings commenced, accompanied by frequent shocks of earthquakes; and these alarming phenomena continued to terrify the inhabitants for fifty or sixty days. About the beginning of September everything seemed to announce the re-establishment of tranquillity; but on the night of the 28th the horrible subterranean explosions were renewed, and an area of four square miles rose up, like an enormous bladder, to the height of above 500 feet. Those who gained the mountains around saw flames shoot up, from a surface of a square league in extent, and huge fragments of ignited rock hurled into the air through a dense cloud of ashes. The softened surface was seen to undulate like an agitated ocean. The waters of two streams precipitated themselves into the burning chasm, and this seemed to add fresh fury to the flames. Thousands of small burning cones, from six to eight feet high, issued from the softened and inflated surface; and in the midst of these *hornitos* or ovens, which still pour out steam, and emit the sounds of internal ebullition, six vast mountain masses arose, to a height varying from 300 to 1690 feet above the former plain. The most elevated of these is the *Volcan de Jorullo*, which is perpetually burning, and has ejected a vast quantity of ashes and scoriaceous lava, often mingled with fragments of primary rocks. The ashes of this eruption were scattered to a distance of 160 miles. The eruptions of the Jorullo continued till February 1760 without intermission, but they have since become less and less frequent. On this catastrophe Humboldt justly remarks, that an event, "by which so considerable an extent of country entirely changed its appearance, is perhaps one of the most remarkable physical revolutions in the annals of our globe. Geology indicates parts of the ocean where, within the last two thousand years, several small volcanic islands have been formed; but it gives no other example of the formation, from the centre of a thousand burning cones, of a mountain of scoriæ and ashes 1695 feet above the level of the adjoining plain, upwards of thirty-six leagues from the sea, and forty-two leagues from every other active volcano;" and he adds, that though within six days' journey of the Mexican capital, this wonderful event had remained unknown in Europe until the period of his journey (No. 11).

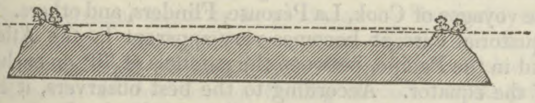
No. 11.

In the works of the South Sea missionary Ellis there is an interesting account of the volcano of Kiraueа, in the Sandwich Islands. The devastating effect of volcanic fire in the island of Hawaiah had been noticed by Captain Cook, but it has been particularly described by Mr Ellis. The route to the present volcano is over a vast waste of naked lava. Instead of a mountain-crater, however, Kiraueа presents a chasm in a plain, perhaps occasioned by the engulfing of the previous elevation. He describes it as a flat area of fifteen or sixteen miles in circumference, sunk from 200 to 400 feet below the level of the country by which he approached Kirauea. In the bottom of this area yawns an immense abyss, in the form of a crescent, about two miles in length from north-east to south-west, and about a mile in breadth at its widest part. One portion presents a flood of glowing matter in a state of terrific ebullition. Fifty-one conical islets, containing as many craters, rise around the edges, or from the surface of the burning lake. Some of them emit flame and smoke, and others occasionally vomit streams of lava, which roll in blazing torrents down their black sides into the boiling flood below. The sides of the gulf just described are perpendicular, and rise from a wide horizontal ledge of solid lava of irregular breadth, but extending completely round the chasm; and beneath this ledge the sides slope to the burning lake, the surface of which appears to be from three hundred to four hundred feet lower.

Besides this volcano, there are several others now extinguished in the island. Of these, one is Mouna Roa, which Captain King calculated, from the position of its perennial line of snow, to be 16,020 feet in height; and the same navigator assigns to another, Mouna Kaah, the vast elevation of 18,000. In a word, the researches of Mr Ellis would lead us to infer that the whole island of Hawaiah, an area of about 4000 square miles, is covered by lavas and other volcanic matters in various stages of decomposition.

The whole islands in the Pacific are divided by Kotzebue into two classes; the *low* and the *elevated*. The former are coral reefs, of which the formation has been so well described by Captains Flinders and Beechy. Their bases would appear to be submarine mountains, which are brought to the surface of the waters by the depositions of the coral animalcules. Captain Beechy examined thirty-two of these islands, the largest of which was thirty miles, the smallest one mile, in diameter. Twenty-nine had lagoons within their centres, which seem once to have existed in them all, until they had been filled up by the operations of the zoophytes. These low coral islands present a singular appearance. (No. 12, a section.) They often form chains, extending for hundreds of miles with little interruption. Their exterior is a border of dead coral rock, and stands a few feet above the waves, on which the seeds of plants, wafted by the sea, soon fix their roots, and speedily a verdant wood encircles the island, whilst its central lagoon is still the habitation of living zoophytes. The elevated islands of the Pacific very generally abound in volcanic products, and numbers of them are still the seats of active volcanoes. Many of them have the appearance of having been raised from the deep by submarine volcanoes; and Mr Lyell has with much force of reasoning contended, that numerous coral islands ought to be considered as the cones of extinguished submarine volcanoes covered over by coralline formations. If we adopt this idea, and extend it to the enormous coral reefs described by Flinders, King, Horsburgh, and Chamisso, the surface of the Pacific must repose upon a prodigious magazine of volcanic energy, which is from time to time destined to increase the surface of the habitable globe. A very extensive line of active volcanoes exists in the Great Eastern Ocean, which has been noticed by Lyell, and forms too remarkable a feature on our globe to be omitted in a sketch of physical geography. It commences in Barren Island, off the coast of the Malayan peninsula; is continued by a chain of active volcanoes through Sumatra, Java, Sumbawa, and Flores; it then turns northward through the Moluccas, the Philippines, Formosa, and Loo-Choo; it passes through Japan, Jesso, and the Kuriles; reaches the peninsula of Kamtschatka, and terminates in the Aleutian Islands, after a course of between 9000 and 10,000 miles, besides the several branches which are sent off to the eastward in the directions of Papua and the Ladrone Islands.

No. 12.



Cause of volcanoes.

The cause of volcanic phenomena is involved in obscurity; but various conjectures have been proposed by geologists. The Neptunian hypothesis has ascribed them to the inflammation of beds of coal, or of other combustibles, in the burning mountain; regarding them as local, or very limited in their range. Lemery's experiment on the heat extricated by moistening a mixture of iron filings and sulphur, and burying it in the earth, was supposed to afford a satisfactory explanation of the manner in which the fire might originally be kindled; and the extinction of volcanoes was supposed to give probability to the local nature of the heating cause. Abbé Breislac modified this hypothesis, by supposing that volcanic fires were fed by collections of petroleum collected in caverns, and set on fire by the chemical action of several other substances. Both these views seem to afford too narrow a basis for the extent of volcanic energy, the apparent connection between distant volcanoes, and the great length of time that some of them are known to have remained in activity. The Huttonians consider volcanoes as spiracles connected with the great source of central heat. (Playfair, 86.)

Another hypothesis has been suggested by the discovery of the metallic bases of the alkalis and earths. Their bases have been supposed to constitute the interior of the earth; and when water finds its way to them, through fissures in its crust, it will be rapidly decomposed, with the extrication of intense heat and the evolution of elastic gases, and thus the phenomena of earthquakes and volcanoes may be produced. This view, originally suggested by Sir Humphry Davy, has been illustrated by Humboldt, and especially by Daubeny, with great ingenuity; and although it has not yet arrived at the state in which, perhaps, we are entitled to denominate it a *theory*, it is an hypothesis which affords a satisfactory explanation of the observed phenomena.

All the enumerated causes have produced and are still producing changes upon the surface of the globe; some of which are general, though slow in their operation, whilst others act much more violently, but are more local in their effects.

Mud and air volcanoes.

Mud and air volcanoes, as they have been termed, appear to owe their existence partly to the disengagement of gases by subterranean fire, but in a great measure to water from a higher level, compelled to pursue a subterranean course, by a thick bed of tenacious clay suddenly escaping by a perpendicular fissure, with a force proportional to the height of the aqueous column. An ingenious explanation of the phenomena of the mud eruptions of Sicily and Italy, on this principle, is given by Dr Daubeny. One of the most noted eruptions of this sort is that of *Macaluba* in Sicily, which in 1777 threw up a vast column of mud, mixed with stones and naphtha, and the disengagement of sulphureous vapours, with much hydrogenous gases. Similar eruptions occur near Catania, and also near Modena. The gaseous exhalations of the *Grotta del Cane* and of the lake of *Ansanto* in the kingdom of Naples, are probably disengaged from mineral bodies by heat. The inflammable air of *Pietra Mala* near Bologna, and of the *petroleum wells* of the country around Baku, on the western shores of the Caspian, are evidently connected with subterranean fire. In the latter district there are strong proofs of volcanic agency still active in the bowels of the earth. The singular eruption which M. Figalgo saw at the northern extremity of Prince William's Sound in North America, belongs to the same class. "The Indians conducted him into a plain covered with snow, where he saw great masses of ice and stones thrown up to prodigious heights in the air with a dreadful noise." (Humboldt.)

Sect. VI.—*Distribution of the Waters of the Globe.*

Natural water never exists in a state of absolute purity. When collected as it descends from the atmosphere, it always contains air; and when derived from springs, lakes, or rivers, it invariably contains more or less of saline ingredients. Dr Henry found in spring-water between four and five per cent. of its bulk of gas, of which nearly three and a half consisted of carbonic acid, and the rest of atmospheric air. Besides the gases, natural waters contain the following salts; muriate of soda, muriate of lime, sulphate of potassa, sulphate of lime or of magnesia, carbonate of lime, and sometimes carbonate of soda. Hail and snow water, when collected at a distance from habitations, contains scarcely any trace of these salts. Rain-water is next in purity; but dew-water is generally contaminated with vegetable matter, as well as with salts. The water of springs usually abounds with these salts, and often with other ingredients. River-water differs much in its purity; but when it flows through a siliceous rock it is often very pure. Lake-water is subject to much contamination; but often, when the lakes are deep and extensive, the water is depurated by subsidence and rest; though stagnant water, when shallow, becomes contaminated with vegetable and animal matter. The water of the ocean contains about three per cent. of saline contents, or one thirty-third part of its weight. The quantity of saline matter appears to increase slightly from the highest latitudes towards the equator. The ocean, from its extent, claims our first attention.

Ocean.

1. Ocean.—From data already given in section second, we shall probably not err if we estimate the surface of the whole ocean and its branches at 144,473,000 square miles. It is not so easy to arrive at a safe conclusion with regard to its mean depth. Laplace and later investigators seem to believe that the depths of the ocean may be in proportion to the elevation of the land, and the ratio of their respective areas. Mrs Sommerville states, that although it is probable that profound cavities of small extent exist in the bed of the ocean, its mean depth does not exceed the mean height of the continents and islands above its level. According to Lagrange, the velocity of the tidal wave is a function of the depth of the channel through which it moves; and recent investigations respecting the velocity of the tidal wave in these seas, would lead us to infer that the mean depth of the sea around the coasts of England is about 120 feet, on those of Scotland 360 feet, on the western coast of Ireland 2000 feet, and in the main Atlantic 50,000 feet, or a little more than nine miles and a half. The examination of the co-tidal lines on Whewell's charts would lead to the conclusion that no considerable extent of the ocean has a greater depth than the Atlantic. If the depths of the ocean are indeed proportional to the elevation of the land, in the ratio of their respective surfaces, the greatest profundity of the oceanic abyss would be about fifteen miles, and its mean depth, at a distance from the land, would vary from one to five miles. If we assume four miles as its mean depth, this would give 577,892,000 cubic miles as the volume of the whole waters of the globe; or, if we reckon it five miles in depth, the mass of waters would equal 722,365,000 cubic miles.

Waves.

The waters of the ocean are in perpetual movement, from the effects of winds, currents, and the tides. The effect of winds in agitating the ocean is chiefly confined to its surface. The most powerful waves in the free sea only rise to the height of a few feet; and it is highly probable, that in the profound depths of the ocean, there reigns a perpetual stillness, unruffled by any movement, except in as far as general currents may disturb the tranquillity of the waters. The surface, acted upon by strong gales, is thrown into long ridgy waves, which rise with an uniform swell, and maintain the same velocity for considerable distances, the top curling in foaming surges, which are precipitated on the undulating surface below, often to the great danger of the navigator. No region of the ocean is subject to more violent oscillations of this nature than that portion of the Atlantic termed the Bay of Biscay, when agitated by a smart gale of westerly wind. Geometry has been applied to measure the velocity of waves, and Lagrange estimates, that where the depth is not very great, the velocity will be the same as a heavy body would acquire in descending from a height equal to half the depth of the water, and that the velocity of the wave is in the duplicate ratio of the depth of the channel in which the water moves. It is believed, however, that the wildest tempest in the open sea does not agitate the water at the depth of an hundred feet; but when waves meet with resistance, as when they dash upon lofty cliffs, we have known them rise apparently in one unbroken mass to the height of two hundred feet.

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There are other movements of the waters of the ocean, termed *currents*. The most general currents are produced by the movement of the waters perpetually setting from the polar regions towards the equator, and the progression of the tropical seas towards the west. Both are chiefly caused by the centrifugal force of the earth's diurnal rotation. This produces a culmination of water towards the equator, and thus a current is generated towards the part of the earth in most rapid motion; but the water accumulated there passes off before the influence of the trade-winds; and the strength of the western current is increased by the mobility of the particles of water preventing the fluid immediately acquiring the velocity of that portion of the earth over which it arrives in its progression towards the equator, by which it will appear to have a motion from east to west, or in an opposite direction to the earth's rotation. The higher density of the sea, when it has been cooled by the polar ices, will increase its tendency to displace the lighter waters, which are forced westward by the constant pressure of the trade-winds, and the other causes already mentioned. The currents from the north have been well described by Martens, Scoresby, and other navigators. The set of the current from the antarctic regions has been illustrated by the voyages of Cook, La Pérouse, Flinders, and others. The equatorial current becomes very apparent in the Atlantic and in the Pacific, between the parallels of 30° on each side of the equator. According to the best observers, it has a mean velocity of nine or ten miles per day in the open sea. In the Atlantic it produces that remarkable movement of the waters termed *the gulf-stream*. This current passes between the West Indian islands, and sweeps along the northern coasts of South America, from Cumana to the isthmus of Darien; from thence it stretches toward Cape Catoche in Yucatan, and, after wheeling through the Mexican Gulf, it rushes through the channel between Cuba and Florida, passing between the Bahamas and the United States of North America towards Newfoundland. In the latter part of its course it can be distinctly traced, not only by its effect on the dead reckoning of ships, but by the superior temperature of its waters, which betray its tropical origin, and by its greater depth; for it appears in a long succession of ages to have hollowed out for itself a submarine channel. In the Bahama Channel it has a breadth of fifteen leagues, and its waters have, in latitude 42°, a temperature of 71° Fahrenheit, whilst that of the adjacent sea beyond its influence is only 63°. The gulf-stream flows with diminished velocity as it proceeds northward, until it is lost on the banks of Newfoundland, where it encounters the great current from the arctic regions. This vast sub-marine bank, indeed, probably owes its origin to the deposition of the solid particles borne along by both currents, at the point where their opposing forces meet; and there can be little

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doubt that the *eastern* movement of the waters of the Northern Atlantic is the resultant of the compound motion of these mighty oceanic streams. It has been computed from the average velocity of both, that the waters of the Atlantic, between the parallels of 10° and 43° north, perform a circuit of about 3800 nautical leagues in thirty-four months. The retrograde current preserves a general easterly direction after leaving Newfoundland; but it reaches considerably farther north, for its influence frequently throws on our western shores the trees and ligneous fruits of the Antilles; but the great body of it is deflected to the southward at the Azores, partly by the influence of the polar current from the north; and then sending a branch to enter the Straits of Gibraltar, gives rise to that dangerous current which has been described by Major Rennell as the cause of the frequent shipwrecks on the African coast within the Canary Islands, when the mariner, by reckoning, considers himself as far to the westward of Teneriffe.

Another branch of the great western current of the Atlantic appears to be deflected by the peculiar form of South America, from the latitude of Pernambuco, along the eastern coasts to Cape Horn; and, doubling that promontory, it finds its way into the Pacific. There is also a general western current in the Great Pacific. Ships are carried by this with great celerity from Acapulco to the Philippine Islands; but, in returning, it is found advisable to sail northwards, for the benefit of the variable winds and of the polar currents. In the Southern Pacific, the polar currents, being little interrupted by land, proceed with less deviation from their course than those in the northern hemisphere; and hence they carry icebergs nearer to the tropical regions than we ever find to the north of the equator. The western motion of the waters of the Pacific is interrupted and broken by the vast chain of islands, shoals, and sub-marine banks which stretch from China to New Zealand. The general direction is changed or modified by the form of these lands; and the vast mass of New Holland is one cause of those dangerous currents around its shores which were noticed by Cook, La Pérouse, and Flinders. The weakened force of the general current in the Indian seas permits its interruption by the variable direction of the *monsoons;* but the current which always sets from Australia towards the Bay of Bengal seems to be produced by the modifying influence of the south polar current on the general equatorial current when weakened by the interruption of islands. The direction of this current, finding obstacles to its progress in a north-west direction, and being resisted by the banks and islands which stretch between Cape Comorin and Madagascar, is deflected to the south-west, forming the current in the Mozambique Channel, and thence sweeping round the Cape of Good Hope in a powerful stream, not less than forty-three leagues in breadth. The entrance into this current may be ascertained by the sudden increase in the temperature of the water to eight degrees beyond that of the adjacent ocean. It is probably to this current that the vast shoal off the Cape, known by the name of the Aguillas Bank, is to be attributed. It appears to round off upon both sides, forming a bank forty leagues in breadth, and 160 leagues from east to west.

The strong current through Bass's Straits, separating New Holland from Van Diemen's Land, is but a part of the general western current; but in its passage through the intricate channels between the islands, reefs, and shoals of the ocean north of Australia, it is divided and modified in a thousand different ways. There is another current less easily accounted for. On the western coast of Africa, about thirty leagues from the land, a strong current appears to set eastward in the Gulf of Guinea, and often draws ships far off their southern course. It seems to be a species of eddy, produced by resistance to the polar current caused by the sudden contraction of the Atlantic from the form of the opposite coasts of America and Africa. These currents may be considered as general; but there are other currents which, though special, are remarkably constant. Of these we may notice the perpetual current which sets into the Mediterranean through the Straits of Gibraltar. It occupies the middle of the Straits. On either shore a less powerful and less extensive current alternates with the tides; but there is a constant and powerful influx from the Atlantic into the Mediterranean. A perpetual current sets out of the Baltic to the Northern Ocean; and here also smaller counter-currents are found on the coasts of Sweden and Jutland. Another considerable local current perpetually sets from the Black Sea in the Mediterranean. The causes of these peculiarities we shall afterwards explain.

Tides.

Besides the motions already described, the waters of the ocean are subject to alternations in the level of its surface in any particular place several times a day. The rising of the water is termed *flood*, the fall is named *ebb-tide.* The connection between the tides and the moon were long observed before any theory was proposed to account for them. Descartes ascribed the flood to the pressure of the moon on the earth's atmosphere; but Kepler first suggested that it might arise from the attraction exerted by the moon; and this theory was confirmed and enlarged by Newton, who showed how well the general phenomena might be explained on the principle of universal gravitation. The theory and the phenomena are given under the article ASTRONOMY; to which we refer for the explanation of the two floods and two ebbs daily, how the united influence of the sun and moon causes the two spring and two neap-tides during each lunation; and why the highest tides of all take place about the equinoxes, when the sun and moon are on the equator, and in *perigee.*

The phenomena of the tides accord well with the theory in the open sea; but in the vicinity of land, amongst numerous islands, or in deep inland basins, their regularity is affected by various causes, as the occurrence of strong gales in particular directions, the form of points of land, of banks, and shoals, and the mechanical influence of narrow channels. Thus the tides of the German Ocean take twelve hours to reach London bridge; and consequently the time of high-water there is just as a new flood is commencing in that sea. The usual rise of the tides in mid-ocean is about three or four feet; but on the coasts of Britain, especially in the mouths of rivers, the attraction of the land raises them far higher. Thus, at Chepstow, the tide rises from forty-five to sixty feet; and it is recorded that once, from the influence of a strong gale blowing at the same time into Bristol Channel, the rise was seventy feet. In the river of Annapolis, which falls into the bay of Fundy, on the coast of America, the spring-tides have been known to reach the surprising height of 120 feet. In such cases the flood-tide often rushes in with a vast mass, like a huge wave, several feet above the general surface, which is termed a *bore*, and is dangerous to ships that may have been stranded on the receding of the tide. Something similar is often seen in our smaller rivers, and on such extensive flat sands as those in Morecamb Bay on the coast of Lancashire, and in the Solway Frith. In narrow straits the tide runs with great velocity, such as no ship can stem even with the most favourable breeze. In the embouchure of the Mersey, the ebb-tide has a rate of five or six miles an hour. In the Pentland Frith, between Caithness and the Orkney Islands, the spring-tides have a velocity of nine miles an hour.

Whirlpools.

Whirlpools appear to be occasioned by currents meeting with sub-marine obstacles, which throw them into gyration. When the movement is rapid, the centre is the most depressed portion of the rotating circle, and objects drawn within it are submerged in that point. Several small whirlpools, capable of whirling round a boat, are seen among the Orkney Islands. That of Coryvrechan, in the narrow channel between Scarba and Jura, in the Western Islands, is caused by a rock of a conical form rising abruptly from the bottom, where the depth is 600 feet, and reaching to within ninety feet of the surface. This obstruction, in a tortuous rocky channel, causes a succession of eddies; and when the flood-tide sets in, with a fresh breeze in the opposite direction, the eddying waters rise in short heavy waves, which are highly dangerous to boats, and even to decked vessels.

The Malström on the coast of Norway, near the island of Moskoe, is a whirlpool of a similar kind, the perils of which are probably much exaggerated. The flood-tide setting from the south-west amongst the Laffoden Isles, especially when it meets with a strong gale from the north-west, produces a great agitation of the waves, and a whirlpool is formed, the roaring of which is heard at the distance of many miles. Its agitated vortices are dangerous to vessels, and it is said that seals and whales, when caught within its eddies, are unable to extricate themselves from destruction.

It is now well ascertained that Charybdis, in the Strait of Messina, owes its terrors to the imagination of seamen in the infancy of navigation, and all its celebrity to poetic fancy.

Colour of the sea.

The sea, when viewed near land, has its colour affected by the nature of the bottom. Where the bottom is sandy, and the depth not very considerable, it has a greenish tint; and this is the general hue of the German Ocean; but when viewed out of soundings, the colour of the ocean is generally of a beautiful deep blue. This may be considered as the natural hue of a deep column of water, from which only the most refrangible colours reach the eye of the spectator placed on a ship's deck; and the greenish tint is produced by the mingling of this hue with the yellowish tint of the sandy bottom. Sometimes partial colours are observed in the ocean. Captain Cook and other navigators describe a brown colour of the sea, produced by myriads of minute mollusca and crustacea. In the Greenland seas, the waters in which the whales chiefly delight are streaked with green. This colour appears in broad streams in the sea; and, when examined by Scoresby, was found to be produced by innumerable medusæ and minute crustacea, the olive-green water containing sixty-four in one cubic inch. Captain Horsburgh mentions a milky appearance of the sea, observed in a passage from China to Australia, which was occasioned by minute globular bodies linked together, and doubtless forming some species of *beroe* or *medusa*. The occasional red colour of the sea on the coast of Brazil and of China is believed to proceed from minute mollusca which float in myriads in the waters at certain seasons of the year. Ehrenberg asserts that the name of *Red Sea* has been given to that gulf from the prevalence of a species of *oscillatoria*.

Phosphorescence of the sea.

The phosphorescence of the sea is a very brilliant appearance which the ocean and arms of the sea frequently assume. It is best seen when a vessel is in brisk motion through the waves, or when a boat is impelled by oars through a calm sea. We have seen this appearance so brilliant that we could distinguish letters in a book by its phosphorescence in the wake of a ship, where it will sometimes form a line of pale lambent light several hundred yards in length. We have also seen from the deck, by its light, the hour on a watch, when in other situations on the deck we could not distinguish the features of the seamen. When the hand is immersed in luminous water, we have found the shining particles adhering to the fingers; and on examining such water in a globular glass vessel by transmitted light, we scarcely ever failed to observe in it several minute animals of the genera *medusa* and *beroe*. These animals appeared to have the power of emitting light by their own efforts, as the water, when left at rest, shone by fits. On counting their number in a glass of water, and suddenly dashing it on the deck, in a dark night, it was observed that the number of luminous points generally coincided with that of the animals in the water, and never exceeded it. We have found these animals in sea-water, from 60° to 37° north latitude, in the Atlantic, and in innumerable bays; and believe that they are very general in the ocean.

The dependence of the phosphorescence of the sea on living animals was long ago asserted by Captain Cook and Sir Joseph Banks. In the voyage from the Canaries to Rio de Janeiro they drew a net through luminous water, and caught a large medusa, which shone brilliantly when taken on board; they obtained from it also three minute *crustacea*, about one tenth the size of the glow-worm, which also were very luminous in the dark. Banks named the first *Medusa pellucens*, and the most brilliant of the second *Cancer fulgens*. Other naturalists have enlarged the list of marine luminous animals, which includes occasional instances amongst the larger fishes.

Temperature of the sea.

A considerable number of experiments have been made on the temperature of the ocean by Ellis, Piron, Flinders, Parry, Ross, and others; but the results are not uniform. Ellis found in the Atlantic that the temperature remained stationary at 50° at depths a little exceeding a mile. Piron, who had sounded to greater depths, found it to decrease with the depth. The mean temperature of the ocean at the surface, and at a distance from land, is higher than that of the atmosphere with which it is in contact; but it is generally lower than the air at mid-day, and higher than the atmosphere at midnight. The ocean over a bank is colder than where it is of great depth. This is ascribed to cold currents being forced upwards by the obstruction; but whatever be the cause, the fact is important, as it may enable a seaman to recognise his approach to land when the atmosphere is obscure and his reckoning doubtful, as was first remarked by Mr Williams.

Saltness of the ocean.

The Southern Ocean, receiving less fresh water than the Atlantic, is rather salter, as is also the Mediterranean; but the Baltic, White and Black Seas, from the size of the rivers they receive, are fresher. According to Marcet their specific gravities are as follows:

Mediterranean	1·02930
Southern Ocean	1·02882
Northern Ocean	1·02829
Arctic Frozen Ocean	1·02664
White Sea	1·01901
Baltic	1·01523
Euxine	1·01418

Sea-water has a mean specific gravity of 1·0280 to distilled water as 1·0000. The late Dr John Murray published an admirable analysis of sea-water, 10,000 parts of which afforded him

Muriate of soda	245·04
Muriate of magnesia	28·63
Muriate of lime	0·00
Sulphate of magnesia	17·04
Sulphate of soda	2·66
Sulphate of lime	9·72
	303·9

Dr Murray detected no trace of muriate of lime, which Lavoisier has stated as high as 20·38, and Pfaff at 31·25. In reflecting upon these discrepancies, he was led to conclude that several of the products obtained may be the results of the mutual decomposition of the salts during the processes for separating them from the water; thus the sulphates of magnesia and of lime would be decomposed by muriate of soda, and when both are obtained from sea-water, we should regard them as results of decomposition. The real ingredients of sea-water would thus be,

Muriate of soda	220·01
Muriate of magnesia	33·16
Sulphate of soda	42·08
Muriate of lime	7·84
	303·9

This doctrine he has happily applied to explain the activity of several mineral waters, the analysis of which only affords inert ingredients.

The saline contents of the ocean do not appear to vary considerably; they, however, increase as we approach to the equator, from $\frac{1}{35}$ to $\frac{1}{24}$, as is proved by the increase of density. The numerous experiments of Bladh of Sweden proved that the specific gravity of the waters of the Atlantic on both sides of the equator increase as they recede from the poles. This table was republished by Kirwan in the Geological Essays, with a reduction of the specific gravity to temperature 62° Fahrenheit. The longitudes of Bladh are from the meridian of Teneriffe.

Latitude.		Longitude.		Sp. Gr. at 68°.	Sp. Gr. at 62°.
N.		E.			
59°	39′	8°	48′	1·0266	1·0272
57	18	18	48	1·0263	1·0269
		W.			
57	1	1	22	1·02669	1·0272
54	0	4	45	1·0265	1·0271
44	32	2	4	1·0270	1·0276
		E.			
44	7	1	0	1·02705	1·0276
40	41	0	30	1·0270	1·0276
34	40	1	18	1·0274	1·0280
29	50	0	0	1·0275	1·0281
		W.			
24	0	2	32	1·0278	1·0284
18	28	3	24	1·0275	1·0281
16	36	3	37	1·0271	1·0277
14	56	3	46	1·0269	1·0275
10	30	3	49	1·0266	1·0272
5	50	3	28	1·0268	1·0274
2	20	3	26	1·0265	1·0271
1	25	3	30	1·0267	1·0273
S.					
0	16	3	40	1·0271	1·0277
5	10	6	0	1·0271	1·0277
10	0	6	5	1·0279	1·0285
14	40	7	0	1·0278	1·0284
20	6	5	30	1·0279	1·0285
25	45	2	22	1·0275	1·0281
		E.			
30	25	7	12	1·0273	1·0279
37	37	68	13	1·0270	1·0276

Dr Traill has published the results of some experiments on water taken up in different parts of the Atlantic, from 53° to 6° N., which also show a progressive increase in the specific gravity of the ocean towards the equator, and likewise as the depth increases.

Lat. 47° 47′ N.	Long. 10° 40′ W.	surface	1·0277
Ditto	Ditto	40 fathoms	1·0280
37° 0′	9°	surface	1·0281
32° 0′	16°	surface	1·0284
Ditto		46 fathoms	1·0286
26°	64°	36 fathoms	1·0287
22° 11′		surface	1·0289
8° 20′	56°	surface	1·0267

This last was apparently affected by the waters of the Orinoco, though out of sight of land.

ce.

The phenomena of sea-ice have been admirably described by Scoresby, who divides it into two kinds, *field* and *mountain ice*. Field-ice has a thickness of from two to three or four fathoms. He mentions single fields 100 miles in length and fifty in medial breadth, with a general elevation above the water of from four to six feet. When the ice is of smaller extent it is termed a *floe*. Mr Scoresby found the specific gravity of ice to sea-water to be as 8 to 8·97, or nearly as 8 to 9, so that ice floats in sea-water with $\frac{1}{9}$th above water; and a field which has six feet above water will have forty-eight feet below it, if the ice be of uniform thickness. When a field or floe is exposed to the dashing of the waves, especially to what is called a ground-swell, it is speedily broken up; but the pieces are apt to collect into what is termed a *pack*, when from the mast-head no opening can be discovered in it. In smaller collections it forms *patches*. The ice is *loose* or *open* when ships can pass between the fragments of floes or packs. By the collision of pieces of ice, the fragments are often heaped on the larger portions, and form *hummocks*, which are thus sometimes raised thirty feet above the general level of the ice. Some ocean-ice is whitish and porous. This affords only a brackish water; for though freezing separates the salt from the ice, the salt water is retained in its pores, and the water yielded is not potable; but ice which looks blackish whilst swimming has a solid consistence, a beautiful beryl-green hue in the air, and when melted affords a potable water, a fact of great importance to navigators in high latitudes. Sea-ice assumes different appearances, according as it is formed in smooth or in rough water. The first process in freezing is the formation of minute prisms; when these form in smooth water, they speedily unite into sheets of ice, which in twenty-four hours of keen frost will attain a thickness of two or three inches, and in forty-eight hours will be able to bear the weight of a man. This sort often forms in the interstices of fields, and is termed *bay-ice*. It sometimes increases to three feet in thickness. When the congelation takes place in rougher water, the crystals of ice accumulate, rendering the water sluggish; and this is termed by sailors *sludge*. When the motion of the waves prevents the concretion into larger masses, it forms what sailors term *pancakes*, which generally attain the thickness of a foot. Both these sorts of ice are termed *young ice*, to distinguish them from the more solid *field-ice*. They often rapidly form around ships engaged in the whale fishery, till no open water can be seen from the mast-head; and they often disappear, from the effects of gales or currents, with an almost magical celerity. The heaviest ice is liable to disruption by the waves, especially when detached from the shores, and when the fields are carried by currents into the open sea. Through the openings thus produced, Scoresby penetrated in one voyage as far north as 81° 30′ N. between Spitzbergen and Greenland; and at another time reached the long-lost eastern coast of Greenland, which he surveyed to the extent of 800 miles. The drifting of fields of ice is a proof of the existence of currents from the circumpolar regions. Scoresby mentions that he has seen a field drift 100 miles to the south in a month, although the wind had been very variable during that time. When ice-fields drift they often acquire a rotatory motion, which brings them into collision with other fields; the crushing of the weaker ice is attended with an awful noise; and the utmost presence of mind in the mariner is often required to extricate his vessel from the encounter of such irresistible forces. *Mountain-ice* or *Iceberg* is the term applied to those enormous masses of ice that are more common in Baffin's Bay than in any other part of the northern seas, and are also very frequent in the Great Southern Ocean. It is now generally believed that they are glaciers originally formed on the cliffs of lofty islands or in abrupt valleys, where their lower part being undermined by the waves, in process of time they thus become detached from the land, and float about, as impelled by currents. Some of the icebergs seen in Davis' Straits have an area of five or six square miles, rise 100 feet above the surface, and are aground in water of 100 fathoms; from which data we calculate, that such enormous masses weigh more than two thousand millions of tons. Icebergs assume most fantastic shapes, as may be seen in Captain Ross's and Captain Parry's Voyages. Large icebergs can only be produced where there is deep water close to the cliffs on which they are formed; and this is probably the reason why they abound in Davis' Straits. In the Southern Ocean icebergs have been said occasionally to be 200 feet above the surface, and Forster describes them as composed of layers of different coloured ice. It is dangerous to approach some icebergs, still more to make fast to them; for sometimes they suddenly split into a thousand pieces, with a thundering explosion, as if they were of unannealed glass; at other times they suddenly lose their equilibrium, and are overturned by the wasting of the submerged parts, whilst the upper portion has lost little of its weight. Icebergs have been wafted by currents and storms far from their native seats. Occasionally they have been encountered in the Atlantic, in latitude 40° north; but in the southern hemisphere they have been frequently seen as low as 35°. The *Ice-blink* is one of those singular effects of extraordinary refraction, by which the existence of open water is often recognised, though it really be beyond the limits of direct vision.[1]

Ice-blink.

The polar ices appear to be subject to periodical increase and diminution, depending on causes not yet perfectly understood. One of the last and most remarkable disruptions of the arctic ice is that described by Scoresby. That able philosopher has traced the usual boundary of the firm ice in close and open seasons; and during one of those periodical disruptions, in which more than two thousand square leagues of ice had broken up, he was enabled to penetrate through the boundary, which had seemingly remained undisturbed for four centuries. Large, however, as this quantity disrupted seems, it is a very small part of the whole polar ices. Leslie computed that a total eclipse of the sun for a single hour deprives our planet of as much heat as would be capable of melting a circle of ice 500 miles in diameter and 150 feet in thickness, which he estimates to be sixty times the extent of what is annually melted in the Greenland Seas; yet the effect of a total eclipse of the sun does not cool the atmosphere more than 3° of the thermometer. We cannot, then, ascribe any important influence on our climate to the melting of this portion of the polar ices.

Inland seas.
Baltic.

2. INLAND SEAS.—A few of the inland seas yet remain to be noticed. We begin with the *Baltic*. This sea differs from the arms of the ocean already mentioned, by its comparative freshness, by its want of tides, and by its sending a current continually into the German Sea. Its freshness arises from the number and size of the rivers it receives, in proportion to its extent. It is a narrow, irregular sea, the extreme length of which is about 1200 miles, with a mean breadth of about 140 miles. This will not give an area of 70,000 square miles, and its mean depth is only about sixty fathoms. Yet it receives forty considerable rivers, and the waters of innumerable lakes, which are the drainage of a country five times as extensive as its whole surface. The immense influx of fresh water into such a small basin, from which evaporation is but slow for a large portion of the year, sufficiently accounts both for its deficiency of salt and for the out-going current. The want of regular tides in the Baltic is a consequence of the same causes that operate in all confined collections of water having narrow communications with the ocean, viz. that the moon must act almost equally on all parts of its surface at the same time, and the oceanic tidal-wave, obstructed by the sinuosities of the narrow channel, only penetrates a little way into the three passages which lead into the Baltic.

Mediterranean.

The *Mediterranean* is the noblest and most remarkable inland sea on the face of our earth. A strong current is perpetually setting into the Mediterranean through the Straits of Gibraltar, especially in the centre; and although there be an eddy on each side, this reflux is far inferior to the quantity flowing in from the Atlantic. This inland sea, which is 2350 miles in length, with a breadth varying from 100 to 650 miles, covers an area of about 1,000,000 of square miles. Its depth is much more considerable near the Straits than that of the adjacent Atlantic. The fine hydrographical chart of Don Vincente Tofiño de San Miguel, republished in this country with additions by Captain W. H. Smyth, R. N., shows, that from the longitude of Cape Trafalgar, where the Atlantic is from fifty to sixty fathoms, the channel deepens as we proceed upwards, until, a little within Gibraltar, it is a thousand fathoms deep, and soon after is beyond soundings. It is also very deep towards its eastern extremity. Between Sicily and Africa its depth varies from a hundred to thirty fathoms; so that there exists in that part of the sea a submarine chain or shoal, which may be considered as an extension of the rock-formations of Italy and Sicily, with deep water on either hand. Besides the perpetual current from the Atlantic, it receives the surplus waters of the Euxine, by the constant stream passing through the strait of the Dardanelles. These immense additions appear necessary to supply the enormous evaporation from its surface. It has been remarked, that the rivers which fall into it are the contributions of a smaller extent of territory than the river-domain of any other inland sea, in proportion to its area; for they are to each other rather less than one and a half to one. Some have contended that there is a current below that setting in from the Atlantic. The only fact offered in proof is stated to have happened in 1712. A Dutch merchantman, laden with wine and brandy, was sunk by a broadside from a French privateer in mid-channel, and a few days afterwards the ship and cargo were cast on shore near Cape Spartel, twelve miles below where the accident happened; but the nature of the cargo probably prevented the complete sinking of the vessel, and she may have drifted within the range of the outgoing current on the African shore. The eastward slope of the bottom of the strait would certainly favour the ingress of the cooler waters of the Atlantic into the Mediterranean, and afford an argument against the existence of this alleged under-current.

There is, however, no need of the hypothesis of a counter-current to explain the preservation of the level of this sea, notwithstanding that it receives several large rivers, and a perpetual supply from the Euxine and the ocean; since Dr Halley has shown, that the amount of evaporation from its extensive surface, in so warm a latitude, is sufficient to preserve its level unchanged.

Tides are but little felt in the Mediterranean. They are only sensible in certain parts of that sea, and seldom rise to six inches above the mean level; but, in the Straits of Messina, the form of the land, and the peculiar set of the currents, give them a more considerable range. These tides, however, are irregular, and are liable to be affected greatly by the direction and force of the winds. The want of considerable tides in the Mediterranean kept the Romans ignorant of the extent of ebbs and floods, and caused them several disasters when they carried their arms to the shores of Western Europe. Even in the time of Tacitus they were imperfectly acquainted with the currents produced by the tides around the northern coasts of Scotland, the difficulty of stemming which the historian ascribes to a "mare pigrum, remigantibus infestissimum."

That large inland sea the *Euxine*, with its branch the Sea of Azof, has somewhat of the characters of the North American lakes in its comparative freshness, which is one cause of the duration of ice on waters that have the same latitude as the finest regions of Italy and France. The surface of the Euxine and the Sea of Azof is estimated as equal to 170,000 square miles; but as they receive some of the largest rivers in Europe, and smaller streams from Asia, the drainage of an extent of country equal to five times their own surface, we see a strong reason why there should be a constant efflux through the Bosporus. This current in the Thracian Bosporus has generally a velocity of from three to five miles an hour, according to the direction and force of the wind. Before this outlet was formed, the Euxine probably united with the Caspian, and constituted an hyperborean sea on the plains of Russia, and the provinces on the Lower Danube; and most probably the floods of Deucalion and Ogyges were connected with *débacles* arising from disruptions of the barrier of this sea.

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[1] Scoresby's Arctic Regions, and Ross's and Parry's Voyages

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According to Pallas, there are traces of the former union of the *Caspian* with the Euxine, in the saline marshy ground and numerous lakes which intersperse the flat countries of Ulagann-Ternik, Alabuga, and Byeloe. The present Caspian is below the level of the Euxine. From barometrical measurements, Parrot stated its surface to be 300 feet below the level of that sea; but the recent trigonometrical levelling of Fuss, Sabler, and Sawitch, which has been conducted with the utmost care, reduces this depression to 101·2 feet. Its length is about 700 miles, and its breadth about 210, which would give it an area of 147,000 square miles. It has a very unequal bottom. Hanway states, that in some places 450 fathoms of line could not reach the bottom; but in other places it abounds in shallows, which render its navigation perilous, independently of the sudden storms to which it is liable. It is without tides; but its shores are subject to irregular floods, from the size and number of its rivers, and the direction of the winds. It is extremely salt, and abounds with fish; amongst which the most important is the isinglass sturgeon, and the sterlet (*Accipenser huso*, and *A. Ruthenus*). Several species of *Salmo* and *Cyprinus*, and a species of herring, are numerous; and there are extensive fisheries of several kinds of seals. How seals found their way into this inland sea, unless at one time it communicated with the ocean, we cannot easily explain.

A

The *Sea of Aral* seems once to have communicated with the Caspian, from the similarity of their fishes, and the numerous salt lakes and marshes that still crowd the intervening space, especially towards the northern extremity. The Sea of Aral is 200 miles by 100, and therefore has an area of about 20,000 square miles. It is extremely salt, though it receives several very large rivers, particularly the Sihon and Gihon, the ancient Jaxartes and Oxus.

B

The inland sea or lake called *Baikal* differs from those already mentioned in being perfectly fresh. Its length is 360 miles, and its breadth forty; so that its area is about 14,400 square miles, including the islands which it contains. This lake or sea is remarkable for its green tint, and the very great inequalities of its bottom. In some parts its depth is asserted to be more than 3000 feet, but then the water suddenly shoals to 150 feet. Considering the mass of water it receives from the rivers Bargazin, Selinga, Angara, and many less considerable tributaries, and that its only visible outlet is the Lower Angara, which is not capable of discharging above a tenth of the water poured into this sea, it is conceived by some geographers, that evaporation, in a climate where the whole surface is annually frozen for five months, could not carry off the surplus, and that therefore the Baikal must have some secret outlet, by which its superfluous waters may reach the ocean. The same difficulty occurs here as with the Caspian and the Aral. How could the seals which it contains have been introduced? They are extremely numerous in its northern part, and as many as two thousand have been killed in one year. Of the fishes, the *omul*, or *Salmo migratorius*, is the most important in an economical point of view; but it also contains *S. salvelinus*, *S. oxyrhinchus*, the carp, the tench, the sterlet, and the isinglass sturgeon. One fish is peculiar to this sea, *Calyonymus Baikalensis*, which occurs in such quantities as to corrupt the air by its putrefaction on the shores after storms, to which this sea is very liable. There are many appearances of volcanic fire in the vicinity of the Baikal. It is probable that the surface of the waters of this inland sea once stood on a higher level than at present, and that thus the salmon and the seal might have been able to surmount the rapids of the Yenisei, or have found their way into the Baikal by the channel of the Lena.

Red Sea.

The *Red Sea* is the only other Asiatic sea which we shall here notice particularly. It is a long arm of the ocean, extending between Asia and Africa for nearly 1500 miles, whilst its medial breadth is not above 100 miles. Until Lord Valentia's voyage, our charts of this sea were very imperfect, and much still remains to be done; but his lordship has established the important point of the superior depth of the western side, although the general depth is inconsiderable. These peculiarities of its form give it more the character of a river than of an arm of the ocean; a circumstance which, with the position of its strait in the direction of the tidal wave from the Arabian Sea, makes it subject to very considerable tides, especially in its lower part; whilst their rise is not prevented by the influx of any river. The less powerful influence of shape, and the influx of the united streams of the Euphrates and Tigris, tend to diminish the height of the tides in the *Persian Gulf*, another inland sea, about half the length of the Red Sea.

Tchad.

The *Tchad*, an inland sea of fresh water, is one of the most considerable of the kind in the world; and constitutes that *Bahr el Soudan*, so long considered as the common receptacle of the rivers of Central Africa. The discoveries of Denham and Clapperton prove that it is one of the grandest features in the kingdom of Bornou. It seems to be not less than 200 miles in length by 150 in breadth; but in the rainy season it becomes greatly enlarged, and encroaches on its flat shores. It is principally fed by the rivers Shary and Yeou. The former flows from the south into the lake, and is a noble, rapid river, half a mile in width. The latter, once supposed to be the Niger, comes from the west, but is not considerable.

Mexican Gulf.

We have already noticed the general direction of the equinoctial current into the *Gulf of Mexico*, from which it has obtained the name of the *Gulf Stream*. The eddying of this current in the great inland basin, the prevalence of the trade-winds, and the enormous quantity of mud brought down by the Mississippi and the less important tributary streams descending from the Mexican Sierra Madre, are, according to Humboldt, rapidly filling up the gulf. The eastern coast of Mexico, from 18° to 26° north latitude, abounds with bars, over which large vessels cannot pass; and, far inland, that distinguished traveller found banks filled with sea-shells but little changed. Were the Isthmus of Darien annihilated, the equinoctial stream would pass round the globe; and this change would probably, ere long, place the feeble governments of Japan and China at the mercy of some European conqueror.

Hudson's Sea.

Hudson's Sea, improperly called a bay, is during a great part of the year encumbered with ice. This basin is almost three times larger than the Baltic, comprehending an area of about 500,000 square miles. It is inhabited by some kinds of cetacea, especially the Greenland whale and the beluga.

Baffin's Sea.

Baffin's Sea is now found to communicate with the polar sea by several openings. Its extent, if we include Davis's Straits to the latitude of Cape Farewell, is only inferior, as an inland sea, to the Mediterranean. It is locked up for a considerable period of the year in impenetrable ice; but in the summer months the ice is broken up, and partially carried off by a strong current, which is continually setting down through the strait. The centre of that sea, however, is occupied either by a series of rocky islands, or by shoals, on which vast icebergs are perpetually grounded. Its desolate shores have been much frequented by our whale fishers, on account of the multitudes of the *balæna mysticetus* that resort to this inlet.

Buffon has justly termed North America the country of *lakes* or of *fresh-water seas.* Commencing in the north with *Great Bear Lake,* we may trace a connection by means of minor lakes to *Slave Lake,* a vast sea of fresh water, about 200 miles in length and 100 in breadth. This last lake communicates with the Arctic Ocean by Mackenzie's River, and with *Alhabasca Lake* by Slave River. A chain of smaller lakes conducts thence to *Winnipeg,* which is scarcely inferior to Slave Lake in extent of surface. Advancing to the south-east, we arrive at *Lake Superior,* which, with the *Michigan* and the *Huron,* may be considered as forming the great inland sea of Canada. Lake Superior has an extreme length of 380 miles, a breadth of 161, and a circumference of 1525 miles; the coasts are rocky, and its depth, in some points, is 1200 feet, but its mean depth may be about 900 feet; and its surface is 641 feet above the sea. The Huron communicates with the Michigan by a channel four miles in length; it is 250 miles in length, varies from sixty to 180 miles in breadth, and has a circumference of 1100 miles. The Michigan is 262 miles in length by 55 in breadth, and has a circumference of 915 miles. The mean depth of the three lakes is 900 feet, which shows that their bottom is 300 feet below the level of the ocean. Their whole surface is computed at 72,930 square miles. We have already pointed out the danger to the whole valley of the Mississippi, should earthquakes ever burst the rocky barrier at the southern extremity of the Michigan.

Lake Erie is connected with the Huron by a narrow channel, which expands into *Lake St Clair,* and again contracts ere it reaches the lower lake. Erie is 230 miles in length, about sixty in breadth where it is widest, and about thirty-five at the mean. It differs from the upper lakes by its comparative shallowness, the mean depth not exceeding 120 feet. From many observations, it would appear that Lake Erie is rapidly filling up. Long Point, at the Big Creek, is stated to have advanced three miles in three years, in consequence of the *alluvion* carried into the lake by its numerous rivers. The connection of this lake with that of *Ontario* is by the river Niagara. The difference in level between the lakes is 330 feet; and, after the river has passed down twenty-one miles, it suddenly precipitates itself over the celebrated cataracts of Niagara, in a fall with a depth of 160 feet. It then flows for seven miles through a deep rocky chasm to Queenstown, where the country suddenly sinks; and it flows seven miles farther, through a champaign country, to Lake Ontario, another fresh-water sea, 171 miles in length and about sixty in breadth. The lakes above the falls abound with many kinds of fish, as salmon, sturgeons, several species of *cyprinus,* &c. The five last-mentioned seas or lakes are computed to have an area of 70,000 or 80,000 square miles.

Lakes.

3. Lakes.—Several of the large collections of water already mentioned have been considered as *lakes;* but that designation properly belongs to those less considerable bodies of water which we are now to notice. Many lakes are salt; and of such, a considerable number exist in Asia. The most celebrated salt lake in that quarter is the

Dead Sea.

Dead Sea, or Lake Asphaltites. Independently of the account in the sacred Scriptures relating to the destruction of the cities of the plain the site of which is now occupied by this lake, the nature of the surrounding country bears evident traces of the ravages of fire in remote ages. The frowning cliffs on its eastern shore are evidently volcanic, thermal waters occur near them, the country around is often to this day shaken by earthquakes, and asphaltum is yet collected on its shores. Some have supposed it the crater of a volcano. The lake is much more saline than the ocean; and although the waters are limpid, their specific gravity is 1·2110. Mr Gordon attests their great buoyancy, and an analysis of the waters by Dr Marcet shows that they contain one fourth of their weight of salts. An hundred parts of water yielded,

Muriate of lime	3·920
Muriate of magnesia	10·246
Muriate of soda	10·360
Sulphate of lime	0·054
	24·580

This saltness of the Dead Sea is evidently owing to the abundance of salt in its vicinity, which all the streams falling into it perpetually deposit in this lake. Although the waters of the Jordan, the most considerable of these, are nearly tasteless, and do not contain above one three-hundredth of their weight of salts, the latter are of the same kinds as are obtained from the waters of the Dead Sea; and it is easy to imagine how this constant supply of saline matter to a lake of narrow dimensions, without any visible outlet, must produce an accumulation of salt, which cannot pass off by evaporation. On the western shores of this lake are the ruins of considerable edifices, and still more ancient remains are said to be covered by its waters.

Messrs G. Moore and Beek have very lately proved, by the temperature at which water boils, that the surface of the Dead Sea is 500 feet lower than that of the Mediterranean; and the correctness of this estimate they confirmed by the barometrical results of Professor Schubert of Munich, which give 500 feet as the depression of the Lake of Tiberias, and 598 feet as that of the Dead Sea.

Genn a-reth.

The no less celebrated *Lake of Gennesareth,* or *Sea of Tiberias,* is still smaller. According to Ali Bey, it is only seven leagues in length by two in breadth. It is embosomed in lofty mountains of a volcanic character, amongst which Mount Thabor is pre-eminent. Ali Bey considers this lake as the crater of an ancient volcano; and the nature of the rocks around, and the thermal springs of Tiberias, favour the idea of the volcanic nature of the country.

The want of any outlet, and the influx of rivers passing through a very saline soil, are the causes of the saltness of the considerable lakes of *Van* in Armenia, and of *Ourmia* in Persia. The former has a circumference of 168 miles; and its waters, though potable, are brackish. *Ourmia,* or *Ourumea,* is not less than 300 miles in circuit, and is probably the saltest of any known lake. Its waters are stated to contain thirty-two per cent. of salt; and the sinking of the waters, during the dry season of the year, leaves a thick crust of salt on its shores, which at some points extends a considerable distance into the lake. There are many other lakes of considerable size in Central Asia; many of them are salt; but the most singular is that in Thibet, which produces tincal or borax, a substance which is imported in flat prismatic crystals into Europe; where it undergoes purification.

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Lakes of America.—If North America be the country of lakes, South America is remarkably deficient in them. That of *Titicaca,* in Upper Peru, already noticed, is the only considerable one in the southern division of the new world. It is true, that in the rainy season, the mighty rivers which water the plains of central South America inundate the low country to an immense extent, converting it into seas with a prodigious area, but of small depth; and it appears that inundations of this sort gave rise to the fable of the *Lake of Parima,* or *El Dorado.*

The Mexican lakes are more remarkable for their elevation of 7450 feet above the sea than for their extent. They are essentially saline, being more salt than the Baltic. The specific gravity of the waters of *Tezcuco* is 1·0215, and the impregnation is derived from a soil containing muriate of soda and carbonate of soda. These lakes have diminished since the Spanish conquest, and the capital is no longer in the lake, but connected with it by a canal. The natural decrease of these lakes has been accelerated by the felling of trees, and by a tunnel driven with immense labour through a mountain, to carry off the superfluous water that formerly often flooded part of the city. Between the inland seas of North America and the Icy Ocean there are innumerable lakes; a circumstance in which the northern portion of the new continent resembles the boreal regions of the old. A lake amongst the defiles of the Rocky Mountains, about the fiftieth degree of latitude, we were assured by the late Mr D. Douglas (a botanist, who several times crossed that chain, and was afterwards unfortunately killed by a wild bull in the Sandwich Islands), presents a remarkable peculiarity. From each extremity it discharges a considerable stream, one of which, falling into the Columbia, finds its way to the Pacific, whilst the other forms a branch of the Saskatchewan, and therefore may be said to fall into the Atlantic, through Lake Winnipeg, the inland seas of Canada, and the St Lawrence.

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European Lakes.—Amongst these some of the most celebrated are the *Lakes of Constance* and *Geneva*. The first receives the Rhine, which was fabled to pass through it without mingling with its waters. Like other alpine lakes, it uniformly increases in summer, by the melting of the mountain snows; and its lowest period is in winter, when its sources are locked up in ice. Its length is thirty-five miles, its greatest breadth is eighteen miles, and its mean depth is 600 feet, but in some places it requires a line of 2130 feet to reach the bottom. Its waters thus fill a chasm about 1000 feet below the level of the ocean.

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The *Lake of Geneva* has an area less than that of Constance; its extreme length being fifty-four miles, and its greatest width fifteen. Its depth is very variable; in some parts it was found by Deluc to be 960 feet, which shows that its bottom is only 200 feet higher than the level of the Mediterranean. Like the Lake of Constance, it receives a river, the Rhone, at one end, and discharges it at the other extremity, near to which the river precipitates itself into a subterranean channel termed *Perte de Rhone*. The beauty of the banks of this lake, and the prospect of the distant glaciers, have given to it great celebrity. The other Swiss lakes, though eminently beautiful, are not of sufficient importance to be described here.

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Italian Lakes.—The beautiful scenery on the *Lago di Como* and the *Lago Maggiore* have been the theme of general praise; but some of the smaller Italian lakes, which seem to be the craters of extinct volcanoes, deserve notice. The lakes of *Nemi* and *Averno* are most evidently so; and the poetical representations of the sulphureous exhalations from the latter may possibly have had a real origin in former periods; but now birds rest with impunity on its surface, and fishes inhabit its waters.

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British Lakes.—Our lakes are in general of small extent. The lakes of Westmoreland and Cumberland are more remarkable for their picturesque beauty than their size, and appear but as insignificant specks in a map of Europe. A few of the Scottish lakes are on a larger scale. Some of them are remarkable for their depth, and probably on that account *Loch Tay* and *Loch Ness* are never frozen. Loch Ness in some parts is 800 feet deep; so that its bottom is not less than ninety or a hundred feet below the bottom of the deepest part of the German Sea, on the eastern coast of Great Britain. The depth of Loch Tay varies from eighty to 600 feet. *Loch Lomond* is the largest of the Scottish lakes, being thirty miles in length by nine in its widest part, and at its northern extremity it is 600 feet deep. In the terrible earthquake at Lisbon, Loch Lomond repeatedly rose and fell several feet. The same took place in Loch Ness. A huge wave rolled with impetuosity from east to west, and the waters sunk and fell repeatedly in an hour. Loch Tay was remarkably agitated in 1783 and 1784, during the violent earthquakes in Calabria. On 22d September of the latter year, two large waves were observed to rush from each extremity of the lake, and coalesce near its centre, leaving about 100 yards of its banks at the eastern extremity momentarily dry; but the water returned and overflowed its usual boundary. The same appearances were repeated for several successive days with less violence; and the agitations of the loch did not cease till the 15th of October.

The agitation to which some alpine lakes are subject when the air is perfectly calm, in which even whole breakers have been observed, is a very obscure phenomenon. It has been often observed on the lakes in the north-west of England, in the Highlands of Scotland, and in the Lake of Geneva. It may possibly be explained by the compression of air in caverns existing in the adjacent mountains, the roofs of which are on a higher level than the surface, and communicating with the bottom of the lakes. If water much charged with air find its way into such caverns, the air separated may be compressed in their roofs, until its elasticity becoming superior to the pressure of the column of water, forces its way into the lake, and thus gives rise to what in England is termed a *bottom wind*.

Irish lakes.

The Irish lakes of *Killarney* and *Lough Erne* are highly picturesque; but the petrifying qualities of the waters of the more extensive *Lough Neagh*, in Antrim, ought rather to be attributed to the qualities of the soil in its vicinity. We possess specimens from that locality of wood converted into siliceous petrifactions.

Periodic lakes.

Periodic Lakes.—The inundations of rivers may be said to form *periodic lakes*; but there are other instances where the cause is more occult, although the effect be no less conspicuous. The best-known instance of this is the celebrated *Lake of Cirknitz*, in Carolina. It is only about eight miles in length by two in breadth. In the beginning of June its waters disappear through several fissures in its basin, and the peasants immediately begin to cultivate its bottom, or to pasture their herds on the rich herbage which its oozy bed soon produces. The crop is removed, and about the end of September or middle of October the waters return, spouting up through several apertures in the earth with great force. With these waters various species of fish appear; and sometimes is seen amongst them that curious animal, so puzzling to systematic naturalists, the *Anguina Proteus* of Laurenti, the *Syren Anguina* of Shaw. This lake is placed in a valley amongst limestone hills, which are well known to be hollowed out into vast caverns. Of these the most considerable is Mount Javornick. The caves are supposed to be the receptacles of subterranean rivers, which, when augmented by the autumnal rains, overflow into the channel which communicates with the basin of the Cirknitz; and when the sources of these floods fail, the waters retreat to their summer level. Other lakes of a similar kind are said to occur in Dalmatia.

Rivers.

4. Rivers.—The size and course of rivers are chiefly determined by the height and direction of the mountain chains in which they originate. Thus the Rhine, the Danube, and the Rhone, the largest rivers in Europe, take their rise in the Swiss Alps. The great rivers of Asia have their origin in some of its lofty central chains. The northern rivers, the Irtish, Ob, Yenisei, and Lena, may all be traced to the Altai; the Ho-yang-Ho and Yang-tse Kiang of China arise in the mountains forming the eastern abutment of the central table-land of Asia; whilst the southern ramparts of that table-land contain the sources of the great river of Cambodia, the Irawaddy, the Brahmaputra, the Ganges, and the Scind or Indus. In Africa, the Nile has one of its sources in the lofty mountains of Abyssinia, and the other in the more distant central chain; the Niger rises in the western chain, runs eastward, is deflected in the kingdom of Houssa

towards the south and west, and finally pours its waters into the Atlantic in the Gulf of Guinea. In America, the Madalena and Marañon spring directly from the Cordilleras of the Andes, which also contain the principal sources of the Orinoco; whilst the more sluggish streams of the Paraguay and Parana derive their waters from a lower transverse chain, stretching to the coast of Brazil. In North America, the Arkansas, Red River, and Missouri, the great feeders of the Mississippi, spring from the Northern Andes, where also are the sources of the Columbia to the west, and of the Saskatchewan, the principal stream, which, flowing into Lake Winnipeg, becomes thus a part of that vast chain of lakes or seas, the outlet of which is the St Lawrence.

Channels of rivers.

The channels of rivers are partly produced by the action of their own waters; but undoubtedly also by some of the causes which we have indicated as disturbing the original arrangement of the solid materials of the earth. Thus earthquakes have often opened passages for rivers through barriers of rocks and mountain chains. It may be admitted, that the continual action of water will excavate the hardest stone; but the ravines through which rivers flow frequently bear no traces of having been formed by the action of water; and the depth of some channels, compared to the scantiness of the stream, scarcely permits us to ascribe the whole to the excavation produced by the water. Thus, it is impossible to suppose that the small stream of the Lauricocha, in South America, has cut its way through the chain of the Andes, which it traverses in a long mural chasm, only twenty-five fathoms wide, but of astonishing sublimity. In other instances, the bottom of the channel itself is even below the level of the ocean; thus, the bed of the Marañon, above its junction with the Rio Negro, and more than 1000 miles from its embouchure, was found by Condamine to exceed 620 feet; which, by the estimate of Humboldt, is more than 100 feet below the level of the Atlantic. This may be a chasm produced by an earthquake, like that which, in 1752, suddenly opened, and received the whole waters of the Rio del Norte (a river which has a course of 1000 miles), so as to lay dry its channel for a distance of fifty leagues; and it was several weeks before the river assumed its usual level. Sometimes the channel of a river near its mouth is much below that of the adjacent sea. It is so in the Marañon; and the same has also been proved with regard to the Mississippi, which, just above New Orleans, is 153 feet deep, that is, at least fifty feet below the mean depth of that part of the Mexican Gulf. In such circumstances it is obvious, that the lower part of these hollows in river channels must be filled with salt water; which, by its superior gravity, will insinuate itself below the descending current. Indeed this takes place in the mouths of all rivers communicating with the sea by considerable channels of small declivity. Thus the lowest stratum of water at London Bridge, at the highest flood, is salt, though the upper current flowing over this stratum is quite potable. The tides in the Marañon are sensibly felt 600 miles from its mouth; and probably the sea-water forces itself up at least thus far beneath the mighty current of the river.

Rivers occupy the lowest parts of valleys through which they flow, and when they are very large their declivities are generally small. The surface of the Marañon, 3000 miles from the sea, has only an elevation of 1235 English feet, which would give less than five inches per mile for its mean declivity; but, from the point to which the tides of the ocean reach, the declivity is considered as not above 0·2 inch per mile. The Ganges, from Hurdwar, where it issues from the defiles of the Himalaya, has a mean declivity of four inches per mile; that of the Volga is about five inches.

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The general form of the channels of rivers, however, especially in a champaign country, indicates, that if not wholly formed, they are greatly modified, by the action of their waters. In fact, their beds are usually proportional to the force of the stream. On the banks of many large rivers we can still trace the different heights at which the waters have formerly flowed. Playfair mentions the existence of four or five successive terraces on the Rhine,[1] each of which has evidently been formed in succession by the river; and hence he concludes that the Rhine once flowed 360 feet above its present level. Similar remarks were made on the Upper Rhone by Saussure. The general effect of the action of the water must be the erosion of the channels in the lapse of ages; and even in the rocky beds of rivers this action of water is very perceptible. Thus the waters of the Niagara have apparently worn away the limestone rock of the falls, and formed a deep ravine through the stony bed, six miles in length from Queenstown, where the cliffs terminate abruptly, to the present site of the Falls. The undermining of the cliffs by this stupendous cataract has caused a recession of the Falls equal to about eighteen feet in thirty years; but we cannot thence infer the length of time that this cataract has existed, because we have no certainty of the equability of the disintegration, nor of the other causes which may have aided or facilitated the process. When rivers which have their sources in lofty mountains flow through extensive plains, they are subject to periodical inundations at the rainy season, or when the snows which feed them are melted by the summer heat. Under these circumstances, the swollen river bears along with it mud, sand, and gravel. A portion of these is deposited on the banks of the river, and thus tends to elevate them above the level of the adjacent country; whilst a portion is swept to the sea by the current, and the materials are there collected into sand-banks, or, by the repellent action of the waves, serve to augment the triangular plain often formed at the mouths of rivers, to which the name of *delta* has been applied. This evident and gradual increase of a delta has given rise to the idea of attempting to estimate the antiquity of existing geological arrangements by such a natural chronometer. Thus, if the increase of a delta at the mouth of any river be a certain number of feet in a given time, it has been supposed that we could thence obtain a measure of the age of the whole alluvial land at that point. But for the accuracy of such deductions several data are required. We must ascertain that the supposed delta is really the formation of the river, and that the rate of increase at distant periods is uniform. In every attempt to solve such problems there is danger of mistaking the effects of general for local causes; and there is strong reason to disbelieve the alleged uniformity of the increase of the alluvial soil at the mouths of rivers. The Po, of late years, appears to have gained upon the Adriatic, at the rate of 228 feet per annum, at its two principal embouchures; but had the annual increase always equalled this, the mouth of the Po at the commencement of the Christian era should have been seventy-eight miles from the present shore, or extended beyond Mantua. But towns fifty miles nearer the Adriatic, in the valley of the Po, have existed from before the birth of Christ. The calculations of Volney, on the advance of the delta of the Nile, are founded on very insufficient grounds; and as yet it must be conceded, that we have no determinations of this sort worthy of confidence.

The currents of large rivers may frequently be traced, by their colour, to great distances in the ocean. Thus the Ganges, when in flood, discolours the sea in the Gulf of

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[1] Works, vol. i.

Bengal to the distance of sixty miles, and its mud covers the bottom at eighty miles from the land. The mud of the Orinoco is carried far into the Atlantic; and on examining water drawn from the sea in latitude 8° 20′ north, that is, in the parallel of the Orinoco, and 200 miles from its embouchure, Traill ascertained that the specific gravity of the water suddenly fell below what it was to the north and to the south of this parallel. The enormous mass of water discharged by the Marañon, according to Sabine, discolours the ocean, and has even considerable rapidity in a direction inclined to that of the equinoctial current, at the distance of 300 miles from the American coast. Fresh water may be obtained from the surface of this current, at a great distance from the shore.

The periodical inundations of rivers depend on great falls of rain in mountainous regions, or on the melting of snows in the neighbourhood of their source. The period depends on the return of these seasons in different places. Within the tropics the rainy season is usually about the time when the sun passes the meridian towards the tropic; and continues until his return to the same place. The floods of the Marañon and La Plata cover a vast extent of unexplored country. The rise of the Orinoco commences in May, its inundation begins in June, and the waters return to their channel in September; from which time they decrease until April of the succeeding year. The inundations of the Lower Mississippi begin in March, are at their height in June, and the river is lowest in October. The waters, at their height, 1000 miles from the sea, attain a rise of fifty feet; at 300 miles, of twenty-five feet; and at 100 miles, of twelve feet. The western bank of the Mississippi forms a vast series of lakes, which are dried up in autumn into arid plains, interspersed with swamps; but the delta below the junction of Red River is a dismal swamp, scarcely elevated above the sea. In the Red River, the Arkansas, and the Lower Mississippi, are found those enormous rafts of drift-wood, formed during the river floods, which sometimes extend for ten or twelve miles in one mass, rise and fall with the stream, yet have a luxuriant vegetation on their summits. The inundations of the Ganges follow a nearly similar course. The waters begin to increase in April, when the rains commence in the mountains in which it has its sources; the rate of its increase is about three inches daily until the month of July, when the rains descend in torrents in the plains. The increase of the river is then more rapid, being about five inches daily; and the country for 100 miles along its banks presents in the end of July the appearance of a vast lake, interspersed with insulated villages and woods. The general height of the inundation-waters in Bengal is about twelve feet, but in some places they have a depth of more than thirty feet. The great river of Ava, the Indus, the Euphrates, and the Tigris, have also their periods of inundation, depending on the circumstances determining the setting in of the rains on the mountains in which they originate.

The inundations of the Nile have long been celebrated. Shortly after the commencement of the rains on the mountains of Abyssinia, in June, the river begins to rise, and attains its greatest height in August. At Cairo the greatest rise is twenty-eight feet; at Rosetta it is no more than four about the middle of August, when the valley of Egypt, with a mean breadth of three or four leagues, and the greatest part of the delta, are covered with one sheet of water. Its increase is irregular; and it decreases gradually until the following May. As soon as the waters are within their usual channel, the soil, moistened and enriched by the sediment deposited from the inundation, is diligently cultivated by the natives.

By such inundations the banks of rivers are usually elevated above the adjacent plains; and when the stream carries down much mud and gravel, the whole bed of the river may become considerably raised above the general level of the country through which it flows. This natural process has been considerably accelerated by art on the Po in Italy. To obviate the evil of sudden overflowings of this river, its channel, and that of the tributary streams, have for many ages been carefully embanked; but the quantity of mud and gravel carried down by its waters is so great, that the bottom of the river is gradually raised, further embankments become necessary, and the repetition of these processes have elevated the whole bed of the river below its junction with the Mincio, until it is now actually thirty feet higher than the general level of the adjacent plains; a circumstance fraught with the utmost danger to the whole country between that point and the sea, should any accident happen to the main embankment.

La colmata.

Where the evil is of less magnitude, the Italian engineers have long followed a remedy, devised, it is said, by Torricelli. When streams bring down much mud, and their channels have been suffered to become elevated above the level of the adjacent plains, the lower ground is subdivided by embanked enclosures; the turbid waters of the river are admitted by flood-gates into the subdivisions, and are there allowed to deposit their sediment. The addition of fertilizing mud thus made, in many situations amounts to four inches in depth by each irrigation, which may be repeated several times in the year. By such means, in five or six years, the soil is raised to a level with the river, and the risk of extensive inundations greatly diminished. The process is termed *la colmata.* It has been very advantageously applied in Tuscany and Lombardy; and if steadily and judiciously directed, under the auspices of a just and vigorous government, might possibly still avert a catastrophe which seems to impend over the districts of the Lower Po.

Rapids and cataracts of Europe;

When river-courses lie amongst mountains, they are subject to sudden breaks, which, according to their depth, give rise either to *rapids* or to *cataracts.* There are many picturesque waterfalls in Scotland, as the Cascade of Fyers and that at Lochleven-head in Inverness-shire, Bruar Cascade in Athole, the Devon Lynn in Clackmannanshire, and the magnificent Falls of the Clyde near Lanark. The most stupendous cascade in Great Britain is the Fall of Glomach, in the district of Applecross, in the parish of Kintail, and county of Ross. At the head of a wild and solitary glen, seven miles from the inn of Shealhouse, the river Girsac is precipitated in one unbroken fall of more than three hundred feet. At the distance of about fifty feet from the bottom, the water impinges on a shelf, whence it falls into a dark pool, amidst naked perpendicular rocks. When the river is in flood, it descends in one unbroken sheet of above 380 feet in height. Wales and Cumberland can boast of many beautiful cascades on a smaller scale, particularly the *Pistil y Cain* and *Pistil y Mouddach,* in Merionethshire. The cataracts of the *Dahl* in Sweden, of the *Staubach* in the Alps, of *Tivoli* and *Terni* in Italy, the less considerable cascades of *Mavraneria,* the far-famed *Styx* of Homer, Hesiod, and Pausanias, in Arcadia, and the Fall of the Rhine at Schauffhausen, are amongst the most celebrated in Europe.

of America;

A cataract may exist in a comparatively flat country, from a sudden sinking in its level. The stupendous cataract of Niagara, in which a large and rapid river, 1650 feet in width, precipitates itself, by two channels, in one vast leap of 160 feet perpendicular, is an instance of such an occurrence. The celebrated cataract of Tequendama, near Bogota, though found by Humboldt to be far less lofty than had been supposed by Bouguer, is still of stupendous height, and one of the most magnificent in the world: a river half the breadth of the Seine at Paris is precipitated into a rocky gulf, at two bounds, to a depth of 540 feet.

of India.

The cataract of the river *Shirawati,* in the Indian province of Canara, exceeds in beauty and sublimity every waterfall which has been hitherto made known in Europe. The country around the village of Haliali, about three miles north-west of the fall, presents the richness of a tropical forest, mingled with cultivation. The traveller comes suddenly on the river. "A few steps more," says Dr Christie, "over huge blocks of granite, bring you to the brink of a fearful chasm, rocky, bare, and black, down into which you look to the depth of a thousand feet." The bed of the river is one fourth of a mile broad, in a direct line; but the edge of the fall is elliptical, with a sweep of about half a mile. This body of water rushes, at first for about three hundred feet, over a slope at an angle of 45°, in a sheet of white foam, and is then precipitated to the depth of eight hundred and fifty feet more, into a black abyss, with a thundering noise. It has therefore a depth of 1150 feet. In the rainy season the river appears to be about thirty feet in depth at the fall; in the dry season it is much lower, and is divided into three cascades of varied beauty and astonishing grandeur; but the smaller streams are almost dissipated in vapour before they reach the bottom. Dr Wilson succeeded in viewing this magnificent cataract from the bed of the river, from which it appears to much advantage.[1]

Number of rivers.

The number of considerable rivers which fall into the sea in different parts of the old continent amounts to 430, and those of the new continent may be estimated at 140, but this seeming disproportion is amply compensated by the vast dimensions of the latter.

Quantity of water they discharge.

Several attempts have been made by philosophers to compute the quantity of water which rivers discharge into the ocean; but it is a problem scarcely admitting of any solution, beyond a probable approximation From the observations of Father Riccioli on the discharge of the river Po, it has been calculated, that the water poured out by all the rivers of the globe is equal to forty-one cubic miles daily, or to 14,965 cubic miles annually. This computation is probably too high. The greatest estimate of the mean annual fall of rain, dew, &c. is not above thirty-four inches for the whole earth; and the superficies of the globe being 196,816,658 square miles, this will afford a mass of water equal to 105,614 cubic miles as the whole that is annually precipitated on the earth. But from this must be deducted all that falls on the ocean, which, if we consider the precipitation in the ratio of their surfaces, will give 38,271 cubic miles as the water that falls on the land. Of this quantity, however, at least two thirds are expended in irrigating the soil or in sustaining vegetable life, and are restored to the atmosphere by the process of evaporation, so that no more than 12,757 cubic miles will become the annual tribute of the rivers of the globe to the ocean. This estimate differs less from that founded on the tables of Cotte than some later speculations on this subject, in which we suspect that the mean annual rain, and the quantity returned by the rivers to the sea, are considerably underrated.

Length of their course.

The length of the course of twenty-two of the principal rivers, and the area of their respective domains or basins, were calculated with much care, and given in a tabular form in the essay on Physical Geography in the last edition of the Encyclopædia Britannica. These elements we here insert, with the addition of a reduction of the proportional lengths into English miles, which has been obtained by multiplying them by 180, the distance between the remotest sources of the Thames and its embouchure at the Nore, that river having been assumed as unity in the first column of the table. The proportion of water discharged by each has been omitted, because the data on which that column was calculated did not seem to be sufficiently established.

Rivers.		Length.	Length in English Miles.	Proportional Magnitude of Basin.	Area of Basin in English Miles.
EUROPE.	Thames	1	180	1	5,500
	Rhine	4½	810	12½	70,000
	Loire	4	720	8½	48,000
	Po	2¼	400	5	27,000
	Elbe	4½	820	9	50,000
	Vistula	4¼	760	13½	76,000
	Danube	9¾	1750	56	310,000
	Dnieper	7¾	1390	36	200,000
	Don	7½	1350	37	205,000
ASIA	Wolga	14	2520	94	520,000
	Euphrate	9¾	1750	42	230,000
	Indus	11½	2070	72½	400,000
	Ganges	10	1800	76	420,000
	Kang-tse, or Great River of China	21½	3870	138	760,000
	Amour, Chinese Tartary	16	2880	164	900,000
	Lena, Asiatic Russia	13½	2430	174	960,000
	Oby, ditto	15	2700	236	1,300,000
AFRICA	Nile	18½	2330	90	500,000 uncertain.
AMERICA	St Lawrence, including lakes	22½	4050	109	600,000
	Mississippi	19	3420	249	1,368,000
	Plata	13½	2430	225	1,240,000
	Amazon, not including Araguay.	22¾	4095	395	2,177,000

A diagram exhibiting the lengths of the courses of the principal rivers on the globe will be found in Plate CCCCIX.

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We have noticed the usual courses of rivers; but sometimes their streams, after flowing through open channels, are engulfed, and afterwards re-appear at considerable distances from their *occultation.* Limestone districts afford many specimens of this phenomenon. In Derbyshire, the small streams named the Hamps and the Manifold sink into a chasm on a common near Ashburn, and re-appear in Islam grounds, three miles below. The stream which issues from the Cavern of the Peak is believed to be the same which disappears near the road from Chapel-in-Frith to Castleton; and the caves of Weathercote and Yordas in Yorkshire exhibit similar instances. The occultation of the Rhine has great celebrity, and attracts numerous visitors from Geneva. The Guadiana, one of the largest rivers in Spain, disappears near the village of *Castillo de Cervera*, and, after pursuing a subterranean course for twelve or fourteen miles, bursts again into day near the high road to Madrid, between Manzanares and Villaharta, at the spot named *Ojos de Guadiana*, or the Eyes of the Guadiana. No country surpasses Greece in the number of its subterranean streams, the peculiarities of which are often clothed in splendid mythological fictions by her ancient bards. The waters of many valleys in the Peloponnesus have no other outlets than ζερεθρα, or chasms engulfing the streams, which are termed *Katavothra* by the modern Greeks. Such are the outlets of the valleys of Tegea, Mantineia, Asæa, Orchomenus, Alea, Stymphalus, and Peneus. A familiarity with such phenomena, and a poetical temperament, readily led the ancient Greeks to conceive still more distant secret communications; and the imagination which peopled every grove and animated every stream with presiding deities, could easily reconcile itself to the fabled loves of Alpheius and Arethusa, which led the enamoured river-god to pursue his coy nymph, beneath the bed of the ocean, from Greece to the shores of Sicily.

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[1] Jameson's Journal, vol. xxiv. for January 1838.

5. Springs.—Springs derive their origin from water raised into the atmosphere by evaporation, falling down in the form of showers or mists on hills, and thence percolating through fissures in rocks, or through porous beds, until they appear at lower points of the earth's surface. Hence springs of any size are rarely found near the summits of mountains. When they occur in such situations, they probably arise from water collected on higher though distant mountains, finding its way, as in the two legs of a siphon, through a fissure open to the air only at its extremities. Springs are most numerous in mountainous districts, because hills readily arrest and condense clouds. The observation of Mr White of Selborne, on the condensation of moisture by a single tree, is a proof of the effect of even small elevations in collecting moisture from the atmosphere. Springs are directed to the surface by the position of the strata or fissures through which they flow. In flat countries, springs sometimes have a long subterranean course, especially when they encounter beds of plastic clay, through which their waters cannot penetrate. Copious perennial springs usually undergo very little alteration in their temperature throughout the year; and therefore very generally indicate the mean temperature of the climate where they occur. But water brought up from considerable depths in the earth, as in those wells which (from having been first introduced in Artois) are termed *Artesian*, has usually a higher degree of heat, which increases with their depth.

A higher temperature than the mean of the latitude is occasionally also observed in large springs, the source of which is perhaps not deep. Professor Traill has stated, that the largest spring in Great Britain, *St Winefrede's Well*, at Holywell, has always a temperature several degrees above the mean heat of our climate, and that at different times he had found it to vary as much as 4° of Fahrenheit. This noble spring may be considered as the bursting out of a subterranean river; for it throws up, it is said, about twenty-one tuns of water per minute, or 30,240 tuns daily. It is worthy of remark, that this spring issues from a hill much disturbed by numerous mineral veins, and probably has its temperature also affected by surface water.

The *Crawley Spring*, from which Edinburgh is supplied with water, though of far inferior size, is yet very remarkable, as it yields 220 cubic feet, or more than a tun, per minute, of the purest water.

The most magnificent spring we have ever beheld is the far-famed *Fountain of Petrarch*, at Vaucluse. It rises within a cavern, at the foot of a vast semicircular precipice of compact limestone terminating a wild valley. In the beginning of autumn, by clambering over a heap of rubbish, the traveller may descend into the cavern, and will find himself on the brink of a gulf of the clearest water, of unfathomable depth, with the deep blue tint of the ocean out of soundings, rising with great force, and an unruffled surface, from the recesses of the mountain. It issues from the cavern through concealed channels, and forms at once the river Sorgue, capable at its very source of moving machinery, and almost immediately navigable for boats. The waters of this extraordinary spring never vary half a degree in temperature. When the melting of snow on the neighbouring Alps increases its sources, the cavern is entirely filled with water, and the stream rushes over the rugged bank at the mouth of the cavern with the tumult of a cascade.

The water of springs always contains air, and some saline ingredients. In good potable water the air usually equals $\frac{1}{24}$th or $\frac{1}{28}$th of its volume; of this one third is atmospheric air, and the rest carbonic acid gas. The saline contents of good spring-water generally vary from $\frac{1}{3000}$th to $\frac{1}{6000}$th of their weight; and such water has a specific gravity of from 1·00016 to 1·00030. Such springs are termed *soft*, and answer well for culinary and other domestic purposes. When the solid ingredients exceed this proportion, the water becomes *hard;* and is less fitted for cooking or dissolving soap, in proportion to the quantity of foreign impregnation it contains. The springs of Upsal, analysed by Bergman, afford a good instance of a very *soft water*. The three purest contained no more than $\frac{1}{3000}$th part of their weight of solid matter, and had a specific gravity of 1·0002. From a *kanne* (about 57,000 grains troy) of the Sandvik spring, he obtained 9·65 of solid contents, in the following proportions:

	Grains.		Grains.
Carbonate of lime	5·5	Muriate of lime	0·5
Muriate of soda	2·25	Sulphate of potassa	0·25
Silica	0·5	Carbonate of soda	0·25

besides four cubic inches of carbonic acid gas, and two cubic inches of oxygen gas.

The same ingredients are found in most potable waters, and many also contain sulphate of lime. The springs which supply Liverpool have a specific gravity of from 1·0026 to 1·0027, and contain $\frac{1}{3840}$ of solid matter. They are rather *hard;* but when the ingredients are in more considerable quantity, the spring becomes a *mineral water*.

Mineral waters.

Mineral springs, besides the substances already indicated, may contain one or more of the following substances: sulphuretted hydrogen, or nitrogen; sulphates of soda, ammonia, magnesia, alumine, iron, copper; nitrates of potassa, lime, and magnesia; muriates of potassa, ammonia, and baryta; more rarely free sulphuric acid, boracic acid, and borate of soda. Muriatic acid uncombined has been detected in the waters of the *Pusambio* in South America, which arise from the volcanic mountains of Purace, and are strongly impregnated with sulphuric and muriatic acids; and in Java sulphuric acid has been discharged by volcanoes in such quantities as to destroy vegetation. Boracic acid is deposited from several of the Tuscan springs, especially from the thermal waters of *Sasso*. The borate of soda is found in some of the lakes of Persia and Thibet. *Mineral waters* may be, 1. acidulous; 2. chalybeate; 3. sulphureous; or, 4. saline. The first generally owe their sparkling appearance and acid qualities to carbonic acid. The second contain either the carbonate or the sulphate of iron. The third owe their fetid smell to sulphuretted hydrogen, or to sulphurets of lime, or of some other alkaline substance. The fourth contain a notable portion of neutral salts, from which they have a disagreeable taste, and are hard waters.

Acidulous and chalybeate:

The acidulous waters almost always contain some alkaline or earthy salt. Such are the waters of Tunbridge, Spa, Pyrmont, Seltzer, and others. The chalybeates generally contain from one to two and a half grains of oxide of iron, or some salts, in each English pint, often combined with other salts. Of this kind are the British springs of Peterhead, Brighton, and the chalybeate sources of Harrowgate and Cheltenham, which last, however, are much mixed with other saline ingredients. These vary from 1·0007 to 1·0010 in specific gravity.

Sulphureous waters:

Our sulphureous waters are potent, and owe their qualities to sulphuretted hydrogen. The principal are, Strathpeffer, near Dingwall; St Bernard's Well, at Edinburgh; Hartwell, near Moffat; Harrowgate, Leamington, and a less known well at Kilburne, near London. Their specific gravity ranges from 1·0042 to 1·0132, especially of those which, like Harrowgate and Leamington, contain much saline matter. Moffat spring contains very little saline impregnation, and its sulphuretted hydrogen amounts to 1·20 cubic inch in each English pint. The old well at Harrowgate contains much saline matter, and 1·75 cubic inch of that gas in the same quantity of water. The thermal waters of Aix-la-Chapelle are very strongly impregnated; containing no less than 5·5 cubic inches of sulphuretted hydrogen.

Saline waters.

Saline mineral waters contain a notable quantity of some of the salts already indicated as found in springs. The most noted in Great Britain are the waters of Dumblane, Pitcaithly, Cheltenham, and Leamington. Their specific gravity varies from 1·0047 to 1·0119. The waters of the two last contain respectively 80·5 and 110·38 grains of salts in each English pint. All these mineral springs are reputed remedies for various diseases, but are evidently unfit for culinary purposes. The source of their peculiar impregnations is the mineral beds through which they flow.

Thermal springs.

Thermal Springs.—The heat of thermal waters has been ascribed, by Hutton, Laplace, and Bischoff, to the agency of a central heat, which is conceived to exist in the bowels of the earth. Some indeed have supposed that their temperature may be derived from the mutual chemical action of local accumulations of certain substances at more moderate depths in the earth. But the long-continued uniformity of their heat has given rise to a modification of this doctrine, which is ably supported by Dr Daubeny. He considers thermal springs as deriving their temperature from the same source as volcanoes, viz. the infiltration of water through the external crust of the earth, to the regions where he conceives the metallic elements of earthy and alkaline bodies to exist. The intense heat extricated during the oxidation of these elements will convert a portion of the water into steam, which, under compression, will attain a high temperature, act on various earthy matters, and communicate its heat to the subterranean waters which issue in thermal springs. The position of such springs in the vicinity of disturbances or upheavings of strata by ignigenous rocks, seems to favour this idea. Whatever may be the cause, we can now no longer doubt that there is within the earth a source of heat, the effect of which is perceived in the increased temperature as we descend in deep mines, and in the distances to which the effects of volcanoes are known to be propagated. The hypothesis of a central heat, unconnected with chemical changes, has been strongly insisted on, from the uniformity of the increments of temperature with the depth of borings for Artesian wells; and the result would lead to the conclusion, that the heat of the earth augments, at an average, one degree of Fahrenheit for every 100 feet of perpendicular depth; so that at the depth of three miles water would be boiling hot. But if we adopt the views of Daubeny, the temperature of particular springs will depend on the variable profundity of the unoxidized materials of the globe, and the supply of water. The temperature of thermal waters seems to be liable to little change in each spring; but in different waters it occurs in every degree, from a temperature very little exceeding the mean of the place, to the boiling point of water.

Table of the Temperature of some Thermal Springs.

Matlock	66°	Vichy, France	113°
Bristol	74	Cauterets, do	130
Buxton	82	Bourbonne les Bains, do.	131
Bath	116	Neris, do	145
Alhama, Spain	118	Plombieres, do	146
Aregos, Portugal	142	Chaudes Aigues, do	174
Gurgitello, Ischia	88	Aix-la-Chapelle, Germany	136
Coquinas, Sardinia	198	Weisbaden, do	158
Nero's Bath, Naples	121	Carlsbad, Bohemia	167
Albano, Padua	121	Borsets, Lower Rhine	172
Thermopylæ, Greece	113	Geysers, Iceland	212
Balkan, Turkey	163		

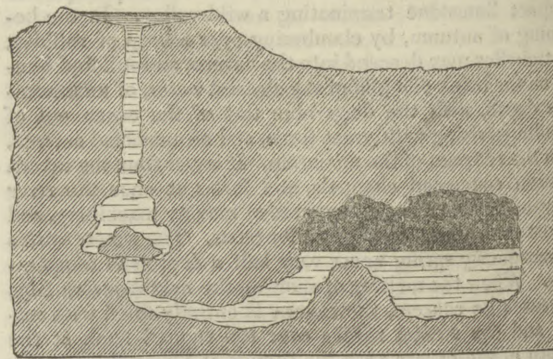
Geysers.

Iceland abounds with boiling springs, some of which are remarkable for their issuing out of a small mass of rock in the midst of a large river, as that figured by Sir George Mackenzie in the *Reikiadalsaa;* others are celebrated for their intermissions and magnificent jets of boiling water, as the *Geysers.* These fountains are well known by the writings of Von Troil, Stanley, Mackenzie, Hooker, Henderson, and by two Danish publications, the first by Olafsen and Povelsen, the latter by Ohlsen. The two principal of these singular fountains are in a valley near Haukadal, about sixteen miles from Skalholt, the bottom of which contains numerous cavities filled with hot water. In the midst of a little mount formed by siliceous deposits from its waters, six or seven feet in height, opens a circular basin fifty-six feet in diameter in one direction, and forty-six in the other. The depth of this basin is three feet; but in its bottom is a round hole about ten feet wide, the termination of a pipe or fissure which sinks into the earth to the depth of seventy-eight feet. By this pipe the water occasionally retires, leaving the basin quite dry, and no steam is then perceived to issue from the pipe. Periodically the water begins to rise in the pipe, and again fills the basin to overflowing; the ground is shaken by hollow subterraneous explosions; suddenly a prodigious column of boiling water is shot into the air with astonishing violence, and clouds of steam obscure the atmosphere. This is followed by successive jets, sometimes to the number of sixteen or eighteen in five minutes, the last of which is generally the most energetic, and attains an altitude of from 90 to 100 feet. On a second visit to the Great Geyser in 1815, Mr Henderson saw it rise to the height of 150 feet; and Lieutenant Ohlsen says that in 1804 he took the altitude of one eruption with a quadrant, and ascertained it to be 212 feet. These efforts are attended with a loud noise, and the ground trembles beneath the feet, whilst the velocity with which the jets and the accompanying steam are hurled into the air is astonishingly sublime. When stones are thrown into the pipe, they remain there until the succeeding jet projects them with great violence into the air, and they may be seen descending amid showers of boiling water. The intermissions of this extraordinary fountain are not absolutely regular; but there are generally four great series of eruptions from its orifice in twenty-four hours.

The jets from the *Strokr*, or *New Geyser* of Stanley, though smaller in diameter, are scarcely less magnificent; and, taking place more frequently, and with surprising violence, afford a high gratification to the traveller.

The mechanism of these Geysers must be simple, to have lasted for many ages. They are mentioned by Saxo in his History of Denmark; and this shows that some of them have existed for about 600 years. It is not easy to imagine an application and removal of a heating cause within the earth in such short intervals; but an arrangement somewhat resembling that represented in No. 13 would be capable of producing a Geyser. A cavity similar to that supposed by Mackenzie or by Lyell, in which water performs the office of a valve, from the form of the lower part of the canal communicating with the surface, might suffice; or its

No. 13.



effect might be increased by a simple valve formed by a mass of stone accidentally getting into the position represented in the figure. Indeed, an experiment of Mr Henderson on the *Strockr* proves the dependence of the force of its jets on some such mechanical obstruction. That gentleman found that the eruptions were accelerated by throwing a quantity of stones into the pipe, and the violence of the succeeding jets seemed to be in proportion to the load so applied; just as loading the valve of a steam-boiler will increase the elasticity of the steam. Henderson asserts that he was thus able to double the effect of the fountain, and to make it project the water to a height of 200 feet. The steam is no doubt produced by the agency of that volcanic fire which everywhere pervades Iceland, and is evidently in great activity under this secluded valley.

If the cavern in the imaginary section, No. 13, be supplied with water from a subterranean source, whilst steam is introduced into it from some more distant volcanic focus, the fountain will remain quiescent until the accumulation of steam, and the pressure of the vertical column of water, aided by the rude valve of rock, will augment its elasticity, until it become sufficient to overcome the resistance, and to project the water remaining in the pipe into the atmosphere.

The Geysers are not confined to the valley near Haukadal; several on a smaller scale exist at Reykum, issuing, at intervals of about an hour and a half, from a bank of hot sulphureous clay.

The waters of the Great Geyser hold a notable proportion of silex in solution, which no doubt is owing to their alkaline impregnation, and their high temperature. According to the analysis of Dr Black, in the Edinburgh Philosophical Transactions, vol. iii., an English gallon contains—

	Gr.		Gr.
Silex	31·58	Argil	2·80
Muriate of soda	14·42	And a little sulphuretted hydrogene.	
Sulphate of soda	8·57		
Caustic soda	5·56		

The silex is deposited in beautiful stalactitic forms in many of the adjacent pools, and the Geysers petrify plants, like other petrifying waters.

In mit- tin rings.

Cold intermitting springs have been well described by the late Mr Gough of Kendal, who divides them into two kinds; *reciprocating*, or such as have a constant but irregular flow; and true *intermitting* springs, in which the issue is entirely suspended for a time, and the water returns at intervals of greater or less regularity.[1] Of the former sort we have a good example in *Giggleswick Well*, in Yorkshire, in which the reciprocations are well marked. In it the water will sometimes rise and fall a foot in ten or fifteen minutes; at other times it will fall as much in four minutes, but usually requires double that time to regain its former height. The water bubbles out with force, so as to carry with it particles of sand. Another reciprocating well occurs near Torbay, called *Lay-well*. It is described, in an early volume of the London Philosophical Transactions, as ebbing and flowing sixteen times in an hour. A similar well, but on a far less scale, is St Anthony's Well on Arthur Seat. The cause seems to be in both instances the confinement and compression of air in tortuous cavities within the subterranean channel of the spring, which, from the position of the aperture, is alternately compressed by the accumulating fluid, until it acquire sufficient elasticity to drive before it the resisting column of water. It is easy to conceive a simple mechanism capable of this alternation, without any species of valve, except that formed by the water itself, which may be represented by the diagram No. 13, without its valve. Of the perfectly *intermitting spring* the most remarkable is the *Bolder-Born*, in Westphalia, near Paderborn. After flowing for twenty-four hours, it entirely ceases for the space of six hours; it then returns with a loud noise, and mixed with air, in a stream sufficiently powerful to turn three mills very near its source. In Lowthorpe's Abridgment of the Philosophical Transactions (vol. ii.), it is said to disappear *twice in twenty-four hours;* and possibly its intermissions are not regular, but may depend upon the quantity of rain which has recently fallen. Dr Boué has described a powerful intermitting spring which occurs at Bihar, in the commune of Maybugyer, in Hungary. It issues, many times a day, from the foot of a mountain, after hollow subterranean noises, in such quantity as in two minutes to fill the channel of a considerable stream. Its returns are most frequent from Christmas to Midsummer, when they take place every quarter of an hour; but they are rarer during the other half of the year.[2]

The most probable manner in which such powerful effects are produced, seems to be the descent of streams of water, much mixed with air, into a cavern, the more direct communication of which with the surface is through a channel so connected with the cavern as to confine the air in its upper part, in the manner of a *water-blast*, until the increasing elasticity, from compression, enables the imprisoned air to dislodge the water accumulated between it and the outlet.

Sect. VII.—*The Atmosphere.*

Atmosphere.

The earth is surrounded by an invisible and highly elastic fluid, termed its *atmosphere*, which accompanies it in all its movements; being retained by the influence of gravitation toward the earth, though, from the repulsion between its own particles, it extends to a considerable distance from the surface. Its density diminishes as it recedes from the earth, and its expansibility is in the inverse ratio of the force by which it is compressed. Its density is farther affected by the influence of heat and cold, by the admixture of watery vapour it contains, by the decreasing force of terrestrial gravitation, and the increasing attraction of the heavenly bodies as its distance from the surface of the earth is augmented. Experiment and calculation have proved that the rate of diminution is such, that the atmosphere at the height of seven miles would only have a density $\frac{1}{4}$th of what it has at the surface; and that if the altitudes be taken in an arithmetical series, the decrease in density will follow a geometrical ratio. Thus, if the density at the surface be assumed as unity, at seven miles it will be $\frac{1}{4}$th, at fourteen miles it will be $\frac{1}{16}$th, at twenty-one miles it will be $\frac{1}{64}$th, and so on. This property of the air would lead to the idea of an indefinite extension of the atmosphere; but there is evidently a limit to this, probably arising from the gravitation of the particles of air; and the nicest observations on the duration of twilight, as well as some other phenomena in astronomy, almost warrant the inference, that the utmost limit of the atmosphere cannot exceed forty-five miles in altitude. See the article Atmosphere.

Its weight.

Air is ponderable; 100 cubic inches of air at the temperature 60° Fahrenheit weigh 30·5 grains troy, at a mean barometrical pressure; and a perpendicular column of the whole atmosphere is just balanced by a mercurial column of about thirty inches in height. Hence the length of such a column is employed to ascertain the weight or pressure of the atmosphere; and the oscillations of the *barometer* have taught us, that this pressure varies in different stations on the earth's surface, and in the same place at different times. See the articles Barometer, Atmosphere, and Meteorology.

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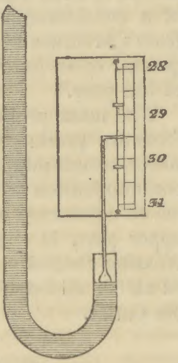
[1] Nicholson's Journal, eighth series, vol. v. p. 35.

[2] Jameson's Journal, vol. xxxv. July 1838.

Register barometers.

The height of the barometer forms an important part of a meteorological journal. Observation has made us acquainted, not only with the occasional, but also with the diurnal oscillations of the column; and exhibited the connection of the more considerable variations with changes in the weather. The trouble of continual attention to obtain the mean heights of the barometer at any place, have given rise to several contrivances for registering the maxima and minima during the absence of the observer. A very ingenious instrument for this purpose is described by Mr Keith, in the Philosophical Transactions of Edinburgh (vol. iv.). The open end of the instrument is a larger cylinder than the rest of the tube. The cistern is placed horizontally at the upper part, and an ivory float, supporting a *kneed wire*, is placed on the surface of the fluid, as in No. 14. The scale is above the opening of the tube, and the kneed wire moves two light indices, sliding on a fine wire, with sufficient friction to retain them in the position which they receive from the movements of the ivory float. The same gentleman caused the instrument, by a slight modification, to record the whole course of its observations through a given period. A perpendicular cylinder, divided into thirty-one compartments, is moved round its axis once a month by clock-work; a pencil attached to the float wire records the whole course of the oscillations; and a proper scale, marked on the cylinder, gives the value of the irregular curves thus traced. Once a month the cylinder is covered with a fresh paper, ruled into thirty-one columns, for another monthly series.

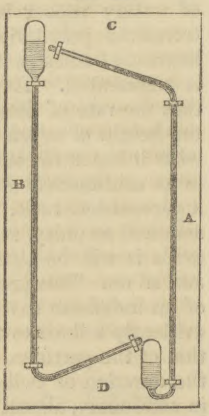
No. 14.



Professor Traill has given a simple and cheap form of a register barometer for maxima and minima.

A diagonal barometer registers the maximum height of the column. Before the tube is bent, a piece of iron wire is introduced into the closed end of the tube, which is then filled in the usual way. The wire being lighter than the mercury, will rise to the top of the column, is pushed before it on the rise of the barometer, and, on the fall, remains, by its own weight, at the point it had attained. A slight modification of Cassini's rectangular barometer marks the minima, by means of a piece of iron wire introduced at the open end of the tube, as in No. 15. To make the indications of both instruments as nearly equal as the construction will allow, the lower part of this tube is bent to less than a right angle.

No. 15.

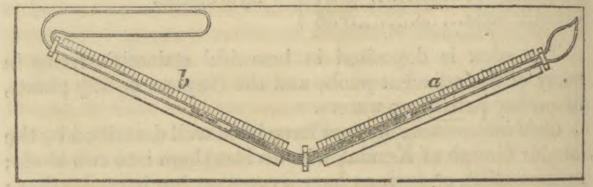


It is obvious that the barometer affords the means of ascertaining the weight of the whole atmosphere. The pressure of the atmosphere varies from twenty-eight to thirty-one inches of the barometric column. A column of pure mercury, whose base is a square inch, and its height the mean between twenty-eight and thirty-one, or 29·5 inches, is found to weigh 14·5 pounds avoirdupois; therefore the pressure of the whole atmosphere will be 14·5 pounds on each square inch of the earth's surface. And as the superficies of our globe is equal to 790,116,426,647,756,800 square inches, if we multiply this number by 14·5, we obtain, as the absolute weight of the whole atmosphere, 11,456,688,186,392,473,600 pounds; or, if we adopt the more common estimate of the mean barometric height at 30 inches, and the weight of that column at 15 pounds on the square inch, this will give 11,851,746,399,716,352,000 pounds, or 5,290,958,214,159,085·7 tons, as the mass of our atmosphere.

The variations of atmospherical temperature are ascertained by the thermometer. (See the articles Meteorology and Thermometer). The instrument, for this purpose, should be placed in the shade, protected against reflected heat, and also against that transmitted through walls, or other bodies to which it is attached. It is by no means easy, in a town, to obtain an eligible position for a measure of atmospheric temperature, on account of the many causes which affect the instrument. It ought to be protected by a glass case against rain; yet the air should circulate freely around it, and it ought to radiate its heat freely to the sky. The importance of obtaining accurate information on changes of the temperature of the atmosphere has given rise to numerous observations on the annual, monthly, daily, and hourly variations of the thermometer.

The labour and minute attention required in such investigations have induced ingenious men to devise methods of ascertaining mean temperatures from a few observations. It has been found that the mean of the thermometer during the month of April will, in our climate, nearly indicate the mean annual temperature; and that the mean of observations made about half past 8 A. M., at 2 P. M., at 9 P. M., and an hour before sunrise, will give the mean temperature of each day. To abridge such fatiguing observations, *register thermometers* have been devised. The best known of these are the thermometers of Six and of Rutherford. (See the article Meteorology, Plate CCCLIV. fig. 6 and 7.) A modification of Six's thermometer, rendering springs to the indices unnecessary, has been constructed by Professor Traill, in which the indices slide in slightly inclined tubes, as will be easily understood from No. 16.

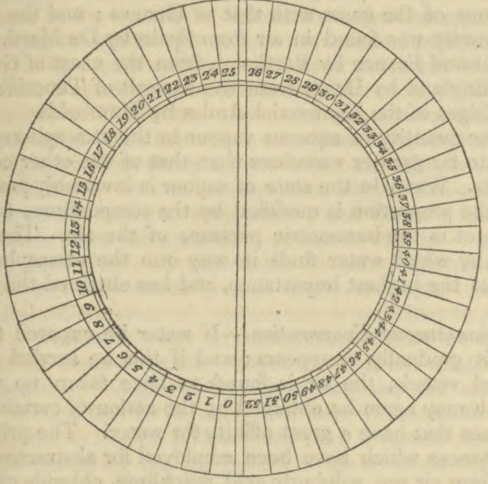
No. 16.



As in Six's thermometer, the expansions of alkohol are the measure of the temperature; the indices, of iron wire, enclosed in glass tubes, are moved by a short column of mercury; and they are adjusted for a fresh observation by bringing them to the extremities of the mercurial column with a magnet.

The atmosphere itself is invisible; but the column of air interposed between the eye and distant objects invests them with an azure hue. This tint depends upon the greater refrangibility of the blue rays of light than of those towards the other end of the spectrum. When a ray of white or undecomposed light enters our atmosphere, the red and yellow rays pass with little deviation from a rectilineal course; but the blue rays are dispersed in the air, and affect the colour of objects beheld through a long column of the atmosphere. As we ascend lofty mountains, the refractive power of the air diminishes with its density, and hence the blue tint is lost in the blackness produced by the want of refraction; until a traveller, on the ridges of the Alps, the Andes, or the Himalaya, will perceive the sky to assume a hue approaching to deep blue or black. Saussure has described this phenomenon, and invented the *Cyanometer*, an instrument for measuring the intensity of the colour of the sky. (See the article Cyanometer.) The form will be best understood from No. 17.

No. 17.



With this instrument Saussure found a numerical value for the colour of the sky at different places. Thus it was at Geneva = 17°, at Chamouni = 19°, on Col du Géant = 31, and on Mont Blanc, at the height of 15,750 feet, it was = 39°. It also showed that the intensity of the colour varied at the same place at different times. The intensity of the colour is greatest at the zenith. It increases towards mid-day, more rapidly on mountains than on plains; and the difference between morning and mid-day is then also greatest; but the whole difference is most considerable in plains.

The following comparative tables of observations on Col du Géant, and at Geneva, illustrate these points. The first column shows the degrees above the horizon, the second the degree of the cyanometer.

Geneva.		Col du Géant.	
1°	4°	5°	16°
10	9	10	18
20	13	20	20·5
30	15	30	29
40	17·5	40	32
50	19	60	34
60	20	60 to zenith	34
60 to zenith	20		

At midnight, on the Col du Géant, the cyanometer indicated 51°.

Some years ago we endeavoured to give greater permanence to the tints by employing thin films of blue glass in constructing a cyanometer. The first degree was formed of a single film enclosed between plates of thin crown glass, and each succeeding degree consisted of an additional film.

To the refractive power of the atmosphere we owe the splendours of sunrise and sunset. When the sun is on the horizon his beams reach the eye through a long column of dense air; the more refrangible rays are dispersed, and the eye receives the red and orange rays undiluted, especially through the serene air of a summer evening. As the brilliant hues of sunset melt away, the blue tone which the atmosphere had acquired by the dispersion of the most refrangible rays, but which was lost in the splendour of sunset, gradually reappears. and, mingling with the ruddy gleam, sheds the purple light of evening on the softened landscape. As the sun descends more below the horizon the purple colour fades away, and gradually gives place to the "faint erroneous ray," that "flings half an image on the strained eye."

Composition of the atmosphere.

Atmospherical air was long considered as a simple substance, one of the elements of other matter; but the discoveries of Black, Cavendish, Priestley, Scheele, and Lavoisier, have proved it to be a compound, of which the principal constituents are oxygene and nitrogene gases, usually estimated at twenty-one volumes of the former to seventy-nine of the latter. Dr Black discovered that the atmosphere always contained carbonic acid, which was found to exist in slightly variable proportions; and it holds water suspended in the state of vapour, in proportions which are still more fluctuating. If we average the two last ingredients, the composition of the atmosphere may be stated as follows:

	Volume.	Weight.
Nitrogene	= 77·50	= 75·55
Oxygene	= 21·00	= 23·32
Carbonic acid	= 0·08	= 0·10
Aqueous vapour	= 1·42	= 1·03

The manner in which these different ingredients are united has given rise to some controversy. The opinion once generally entertained was, that they were united by an affinity between their particles, like that which forms chemical compounds. The celebrated Dr Dalton first suggested the theory, that of the various elastic fluids constituting the atmosphere, the particles of one are neither retractive nor repellent of the particles of another; but that the pressure upon any one particle of such a mixture is entirely derived from particles of the same kind of matter. Each fluid, on this view, is considered as occupying the same space as it would in a vacuum; and each constituent of the atmosphere, under a mean barometrical pressure of thirty inches, as exerting its own separate pressure in the following proportions, depending on its own quantity and specific gravity. Thus, the

	Inches of Mercury.
Nitrogene would exert a pressure	= 23·36
Oxygene	= 6·18
Carbonic acid	= 0·02
Aqueous vapour	= 0·44
	30·00[1]

Eudiometers.

Soon after the composition of the atmosphere was detected, and the qualities of oxygene in supporting combustion and respiration were understood, it was conceived that important modifications of disease might depend on or originate in the varying proportions of this essential ingredient in the air; and various methods were devised for analysing atmospheric air, and ascertaining the quantity of oxygene it contained. 1. Dr Priestley devised a method of doing this by the *eudiometer*, or measure of the purity of the air. His method consisted in adding, in a graduated tube, fifty-five volumes of nitric gas to a hundred of atmospheric air. The property of this gas is to abstract oxygene from the air, and to form nitrous acid, which is absorbed by water; and the amount of the diminution marked the quantity of oxygene in the air. 2. Gay-Lussac improved Priestley's eudiometer. Instead of adding the nitric gas in the graduated tube, he mixed a hundred volumes of the gas with as much of the air to be analysed, in a wide jar, and transferred this mixture to the graduated tube to ascertain the diminution; on dividing the residual air by four, he obtained the amount of the oxygene present in the air. 3. Scheele employed the sulphuret of potassa for the same purpose. 4. Seguin used the rapid combustion of phosphorus; and, 5. Volta exploded a mixture of hydrogene and air by means of an electrical spark. This is one of the most elegant and accurate of the eudiometers. He recommends a mixture of 200 volumes of hydrogene with 300 of air. On passing an electric spark through the wires in the top of the jar, the hydrogene is fired, instantly forms water with the oxygene of the included air, and, in ordinary cases, the diminution of volume of the mixture amounts to 195, of which one third is oxygene, or sixty-five parts of oxygene have been lost by 300 of air, or about twenty-one per cent.

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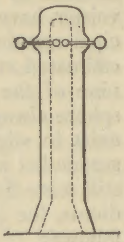
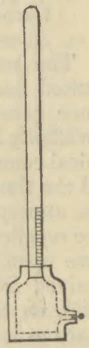
[1] Manchester Memoirs, vol. v. See the article ATMOSPHERE.


No. 18.

6. Dr Hope's eudiometer consists of a graduated tube exactly ground to a small tubulated phial. The bottle may be filled, either with hydrosulphuret of potassa, or with a liquid proposed by Davy (which is formed by saturating sulphate of iron in solution with nitric gas.) The air is in the tube, which is inserted in the neck of the phial; the instrument is inverted; the air, now in the phial, is agitated with the liquid for a few minutes, and on opening the tubulature of the phial, below the surface of the liquid, the amount of the oxygene absorbed will be indicated on the graduated tube. This very neat instrument has been modified by Dr Henry, who substituted a bottle of caoutchouc for the phial. Any of these instruments, especially 18 or 19, will show the quantity of oxygene in any given air; but it has been found that the quantity of oxygene of the air is little subject to variation, and that gas is equally present on mountains and in plains, in the town or in the country, except in confined situations, where fuel is burning, or many animals respiring. Air which is very deleterious to man has no sensible difference in the proportion of the oxygene from the purest atmosphere; and we must probably look to other causes than this for the unwholesomeness of the atmosphere.


No. 19.

Carbonic acid in the air.

The quantity of carbonic acid in the atmosphere is subject to slight variation, except in confined apartments. Dr Dalton found it only varying from $\frac{1}{1400}$th to $\frac{1}{1000}$th of the whole air, an uniformity which is surprising, considering how much carbonic acid is constantly formed during respiration and combustion. Perhaps this may be partly owing to our imperfect modes of ascertaining very minute changes in its quantity. If we are to give credit to the experiments of the younger Saussure, the quantity in the atmosphere is greater in summer than in winter, by 2·3 volumes in 10,000; but his experiments are not generally considered as satisfactory, in a case where the difference appears so great, and the point so difficult of determination. Even the experiments of Dalton are not considered as decisive; for lime-water does not appear to be capable of abstracting all the carbonic acid from air, as was remarked by Cavendish; and philosophers have generally considered the quantity as ranging from $\frac{1}{800}$th to $\frac{1}{1000}$th of the whole atmosphere. In confined apartments, however, the quantity of carbonic acid is sometimes much increased, while the oxygene is consumed in the process of combustion and respiration; and this double vitiation of the air may give rise to fatal consequences, as was too well illustrated in the catastrophe of our unfortunate countrymen in the dungeon of the *Black Hole* in Calcutta in 1756, and in one which happened to persons confined in St Martin's Roundhouse in London in 1742. In the celebrated *Grotta del Cane*, the carbonic acid which issues from crevices in the floor fills the bottom of the cave to the level of the entrance, and then flows out by its superior gravity, so that the upper part is free of the noxious impregnations. A man enters with impunity, because his head is above the stratum of carbonic acid; but the air of the cave is speedily fatal to a dog, because the prone position of his air-passages brings his respiratory organs into contact with the gas. It is remarkable that these gases do not appear to vary considerably in their relative proportions in any part of the accessible atmosphere. Air collected on the summit of Mont Blanc was analysed by the younger Saussure, and agreed in the proportions of the gases with that of Geneva; and the same uniformity was found in air from Spain by De Marti, from Egypt and France by Bertholet, from the coast of Guinea and England by Davy, from the summit of Teneriffe and the ridges of the Equinoxial Andes by Humboldt.

Aque vapou the ai

The quantity of aqueous vapour in the atmosphere is liable to far greater variations than that of the other constituents. Water in the state of vapour is invariably present; but the proportion is modified by the temperature, and by changes in the barometric pressure of the air. The process by which water finds its way into the atmosphere is one of the highest importance, and has obtained the name of

Evapo tion.

Spontaneous Evaporation.—If water be exposed to the air, it gradually disappears; and if this be carried on in closed vessels, the air is found to have taken up water, which may again be obtained by the action of certain substances that have a great affinity for water. The principal substances which have been employed for abstracting water from air are, sulphuric acid, quicklime, chloride of lime, and carbonate of potassa. If given proportions of any of these be enclosed in a vessel containing air, they absorb the moisture of that air; and the weight they thus acquire has been taken as the measure of the quantity of its water. The same is estimated by the quantity of water which is absorbed by a given volume of air thus artificially dried. Some very careful experiments on this subject were made by Saussure, who inferred that a cubic foot of air, at temperature 65° Fahrenheit, when fully saturated with moisture, holds eleven grains of water dissolved. Notwithstanding the acknowledged accuracy and patience of this philosopher, we are inclined to prefer the method of Dr Dalton (founded on the suggestion of Le Roy of Montpellier), of observing the temperature at which moisture begins to be separated from the air. This is termed the *Dew-point* of that atmosphere, and forms an important element in several interesting problems in meteorology. Dalton had shown, that the water existing in the atmosphere has precisely the same elasticity as it would assume in a vacuum at the same temperature; hence it is obvious that it exists in the air, not as water, but as elastic vapour. But the elasticity of vapour is demonstrated to depend on temperature; and, therefore, if we could measure the elasticity, we could determine the quantity of water in the atmosphere. This elasticity is measured by the *Manometer*, a barometer the cistern of which is enclosed in the vessel containing the air, and therefore only affected by the variations of elasticity of the included air. Deductions from these experiments have been given in a tabular form in the Manchester Society's Transactions.

In the article HYGROMETRY there is another table of great value, showing the elasticity, weight, and rate of expansion of aqueous vapour, in air saturated with moisture, at each degree of Fahrenheit's thermometer, from 0° to 100°, which was intended by the author of that treatise to facilitate hygrometrical investigations. In this table the elasticity of the vapour is calculated on a formula deduced by Biot from Dalton's experiments.

The quantity of water suspended in the air is liable to great variation, from several natural causes; and it is chiefly liable to be deposited or separated, on a diminution of the capacity of the air for moisture, by a reduction of its temperature. Warm air is capable of taking up, in the state of invisible vapour, more water than cold air. Thus a cubic foot of saturated air, at 32°, contains of watery vapour 2·350 grains; at 60°, 5·825 grains; at 70°, 7·941 grains. When the temperature of the air is diminished, as, for instance, by mingling with colder currents in the atmosphere, a quantity of water is separated; and, according to the suddenness of the change, will be suspended in the form of visible clouds, or precipitated in fogs or rain.

Changes in the density of the air also affect its capacity for retaining moisture. Evaporation is quicker, everything else remaining unchanged, in rare than in dense air. Saussure found, that water evaporated quicker on the Col du Géant, which is 11,275 feet above the sea, than at Geneva, which is but 1324 feet above that level, in the proportion of eighty-four to thirty-seven. Light air then speedily becomes charged with moisture, which slight changes in temperature are ready to precipitate; and hence a falling barometer is often the immediate precursor of rain.

When atmospheric air approaches its point of saturation with moisture, evaporation goes on slowly, at length ceases, and a slight diminution of temperature is sufficient to precipitate a portion of water on contiguous bodies; we then term the air *damp* or *moist*. This change is not always to be immediately recognised by our sensations; and as the change is important to the success of some processes in the arts, and also to health, philosophers have invented instruments for indicating the approaches of the air to saturation, which have been named

Hygrometers, or measures of moisture. The change in bulk which some vegetable and animal substances undergo, in moist air, has been employed for this purpose. The most common are the twisting and untwisting of a cord of flax or hemp by moisture and dryness; the movements of the natural twist in the beard of the wild oat, *avena fatua;* in the Indian grass, *andropogon contortum*, proposed by Captain Kater; or the arista of the seed of *stipa pennata* (a common inmate of our gardens, and often found in our fields), proposed by Dr Cumming of Denbigh. Unfortunately these substances, though indicating minute changes in the air, are incapable of forming *comparable* hygrometers, and gradually become less and less sensible to the influence of humidity. The same may be said of the animal substances which have been employed in the construction of such instruments. The most simple of the animal hygrometers is Wilson's, formed of a rat's bladder fixed to a glass tube, and filled with mercury to a certain point on the tube when the bladder is moist. As it dries, the contraction of the bladder raises the mercury in the tube. Still more delicate hygrometers were formed by Saussure and De Luc, on nearly the same construction. (See the article HYGROMETRY.) Saussure employed a fine human hair, freed from unctuous matter by boiling in a weak alkaline solution; and De Luc used a slip of whalebone, scraped extremely thin. These animal bodies lengthen by moisture; and, in both instruments, one end of the hygrometric substance was fixed to the frame, while the other was attached to a fine flat wire lapped round an index made to move along a graduated arc by the varying length of the hygrometric substance. In Saussure's instrument, the index was brought back by a small weight as a counterpoise; and the same was effected in De Luc's by a spiral gold-wire spring. Both instruments were graduated by placing them in a jar filled with air saturated with moisture, and then in air dried by quicklime, or some similar body; and the space between these extreme points was divided into 100°, or any given number of degrees.

The imperfection of these instruments, when made by the hands of the inventors with every care, rendered it difficult to have two that gave the same indications under similar circumstances; and the still more fatal objection, that they become altered by time in mobility and delicacy of indication. Although both Gay-Lussac and Biot have endeavoured to show the relation between the indications of the hair hygrometer and the quantity of moisture in the air, we cannot consider the instrument as entitled to confidence.

A very elegant hygrometer was invented by Daniel, founded on the determination of the temperature at which dew begins to be deposited; but for the description of it we must refer to the article HYGROMETRY, as well as for an ingenious substitute devised by Mr Adie of Edinburgh, and another by M. Pouillet. All these depend on the dew-point; and all are liable to the objection, that it is difficult to determine the precise degree at which dew begins to be formed, especially at low temperatures. The original idea of obtaining a measure of the hygrometric state of the air from comparing the indications of a thermometer with its bulb moist and dry, is certainly due to Dr James Hutton, the celebrated geologist. This eminent philosopher made use of a single thermometer, which he carried enclosed in a glass case. This form of hygrometer, neglected for thirty years, has at length become an object of philosophic interest in this country and Germany; and two thermometers are now mounted on the same scale, and the indications of the wet and dry bulbs seen at the same time. This instrument has been termed a *psychrometer*. The most elegant form of an instrument on this principle is the hygrometer of Sir John Leslie, or double air-thermometer; one of the balls is covered with tissue paper, defended by a thin covering of blue silk, while the other is naked; but in order to obviate the effect of light, the dry ball is formed of pale-blue glass. This instrument is described in his original paper, and fully in the article METEOROLOGY of this work. When the covered ball is moistened with water, the evaporation produces a degree of cold in proportion to the dryness of the ambient air; and the air within that ball contracting, the elasticity of the air in the other ball pushes the coloured fluid in the stem towards the covered ball. This transference is marked on a scale, each degree of which is equivalent to $\frac{1}{10}$th of a centigrade thermometrical degree. This hygrometer does not indicate the absolute *dryness* of the atmosphere, but only the degree of dryness it has after being reduced to the temperature of the humid ball. In the article to which we have just referred, there are tables given for correcting the indications of Leslie's hygrometer, and showing the point of saturation at different centesimal degrees, and the corresponding degrees of the hygrometer.

The instrument gives excellent comparative results; and two or three minutes are sufficient to bring the fluid to equilibrium, which marks the full effect of the evaporation; and no farther sinking of the hygrometer is produced by keeping the ball bedewed with moisture. In winter, in our climate, it ranges from 5° to 25°; in our summer from 15° to 55°. It has occasionally been observed as high as 80° or even 90°, and in thick fogs it falls to the beginning of the scale: it rises when the weather clears up after rain, and in long tracts of clear warm weather it remains high. It always falls before rain, and remains low during wet weather. When as low as 15°, the air feels damp; when it is between 30° and 40°, we should term the weather *dry;* from 50° to 60°, *very dry;* and from 70° upwards, it would be called *intensely dry*. In a warm inhabited apartment the hygrometer would not be below 50°; but when below 30°, that room would be felt to be uncomfortably damp.

Annual evaporation.

The mean annual evaporation is an interesting subject, for an approximation to which we are mainly indebted to the experiments of Dr Dalton and Mr Hoyle, at Manchester, in 1796, 1797, and 1798. A cylindrical vessel of tinned iron, three feet deep and ten inches in diameter, was filled with soil; it was provided with one pipe near the bottom, and another one inch from the top. This was left in this state for a year, until it became covered with grass. Bottles were now applied to the end of each pipe, so as to collect both the surplus water which soaked through the earth, and that which ran off at the upper pipe. The soil was soaked with water on commencing the experiment; a rain gage of similar dimensions was placed near the cylinder of tin; and the evaporation was estimated by subtracting the quantity which passed into the bottles from the whole rain.

	1796.	1797.	1798.
Rain	30·629 in.	38·791 in.	31·259 in.
Evaporation	23·725 ...	27·857 ...	23·862 ...

The mean evaporation for each month, deduced from the three years, was

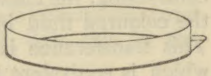
	Inches.		Inches.
January	1·008	July	4·095
February	0·528	August	3·386
March	0·623	September	2·954
April	1·485	October	2·672
May	2·684	November	2·055
June	2·184	December	1·484

giving 25·158 inches for the annual evaporation at Manchester. Dr Dalton considers that we ought to add five inches to this for the annual dew, which will raise the evaporation to about thirty inches.

Evaporator.

From the nature of our climate, the mean annual evaporation over the globe cannot be estimated at less than thirty-four; and this would make the whole mass of water raised from the surface of the earth equal to 105,614·72 cubic miles, or equal to all the rain that falls upon the globe. The evaporation of any place may be ascertained by exposing freely to the air a given quantity of water in a shallow circular dish, accurately turned, so as to have 100 inches of superficies. It should be so placed as not to receive any rain: on measuring the remainder once a week or once a month, we shall obtain the evaporation.

No. 20.



There is reason to believe that the evaporation from the foliage of trees and from herbage is somewhat greater than from an equal area of water, and that the quantity from the surface of new-ploughed land is almost equal to what arises from water; but we have got no good comparative experiments on this subject.

Having considered the conversion of water into an elastic fluid, let us turn our attention to the mode by which it is re-converted into moisture.

Clouds.

1. *Clouds.*—Some have accounted for the suspension of so dense a fluid as water in air, on the supposition that the vapour in clouds existed in the shape of hollow spherules, filled with a lighter fluid than the atmosphere; but this suggestion would seem to be devised rather to meet the difficulty than to be supported by observation; and it is possible to explain the considerable durability of clouds without recourse to any such gratuitous assumption.

The experiments of Volta and Cavallo have shown, that when water is converted into vapour, not only is caloric absorbed, but electricity is also developed. The vapour acquires positive electricity, and the remaining fluid possesses the opposite electric state. By the process of evaporation much electric fluid must be carried into the atmosphere; and when the capacity of the vapour for electricity is diminished by its partial condensation by cold in the upper regions of the air, it may be conceived that the spherules of vapour may become surrounded with atmospheres of electric fluid, the mutual repulsions of which may prevent the coalescing of the particles of vapour into drops so heavy as to descend by their gravity on the earth, especially as a stratum of air charged with moisture is specifically lighter than dry air at the same temperature. The form of clouds, and their different degrees of aggregation, may depend on the electric tension of the atmospheres surrounding the particles of which they are composed; or on a balance between the electric repulsions and the gravitation of the particles for each other. This view is favoured by the generally positively electrified state of the atmosphere when clouds are forming, the heavy falls of rain which accompany electric explosions when the discharge of the accumulated electricity allows the coalescing of the moisture into heavy drops, as well as by the peculiar odour of some kinds of fog, and the highly electric state such fog often exhibits. Beccaria, Romayne, Bennet, and Volta have remarked, that the atmosphere exhibits signs of electricity on the appearance of clouds and fogs. Beccaria always found the electricity of the air *positive;* and Romayne states, that mere diminution of volume in any substance is constantly attended with increased electrical tension. The various forms of clouds, their aggregation in deep masses piled on each other, or their dispersion in long radiated filaments, may be more easily explained on an electric theory than on any other supposition; and the accidental manner in which solar light is reflected from them to the eye of the spectator gives an infinite diversity to their appearance.

For of clou

The vulgar have long remarked the association of certain forms of clouds with the state of the weather; and meteorologists have begun to appreciate the value of a descriptive language for indicating their varied appearances. No system of nomenclature has yet been applied to clouds superior to that proposed by Mr Luke Howard. He divides them into seven species. (See Plate CCCCXI.)

1. *Cirrus.*—A cloud resembling a lock of hair or a feather, composed of parallel, flexuous, or diverging fibres, unlimited in the direction of their increase.

2. *Cumulus.*—A cloud which increases from above, in dense, convex, or conical heaps.

3. *Stratus.*—An extended, continuous, level sheet of cloud, increasing from beneath.

4. *Cirro-Cumulus.*—A connected system of small roundish clouds, placed in close order or contact.

5. *Cirro-Stratus.*—An horizontal or slightly inclined sheet, attenuated at its circumference, concave downwards, or undulated. Groups having these characters.

6. *Cumulo-Stratus.*—A cloud in which the cumulus is mixed with cirro-stratus or cirro-cumulus; the cumulus flattened at top, and overhanging its base.

7. *Nimbus.*—A dense cloud, spreading out into a crown of cirrus, and passing beneath into a shower.[1]

The cirrus is generally formed of white radiated streaks, pencilled on an azure sky. It is the most elevated species of cloud. Its motions are slow. It generally indicates a breeze, and often precedes a storm. Horizontal sheets of cirrus, with streamers pointing upwards, often indicate rain; while the depending fringes are the precursors of fine weather.

The cumulus is generally a dense cloud, moving near the surface of the earth. When large, this species often exhibits large intervening spaces of clear sky. It begins in the morning, and obtains its maximum about two P. M., and usually decreases before sunset, breaking up and disappearing before nightfall. It is the prognostic of settled weather.

The stratus is the lowest modification of cloud, often creeping along the ground, in calm evenings, from lakes and rivers, and rising toward the higher grounds. It often, at night, travels over plains, invests the summits of moderate elevations, but usually melts away before the morning sun. Few days are more serene than those ushered in by stratus.

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[1] Philosophical Magazine; Rees' Cyclopædia; Nicholson's Journal, xxx.

Cirro-cumulus consists of dense rounded masses, in close position. It often forms beds at different altitudes in the air. It is transient in winter, and occurs in the intervals of summer showers. A frequent repetition of it is amongst the best prognostics of fine weather.

The cirro-stratus is narrow in proportion to its horizontal length. It seldom retains long the same form. It is often seen very high in the air, especially that variety which is composed of grouped masses, and is chiefly seen in summer evenings. When seen overhead, it has an uniform hazy appearance; but viewed on the horizon, it often seems very dense, from being viewed edgewise. It indicates rain or storms of snow when it is stationary. It often forms the seat of rainbows and halos when descending from the zenith. It often shrouds mountain summits, and in cold weather often descends into plains as soaking dense mist. The cumulo-stratus usually appears in an overcast sky, and may be regarded as a prognostic of rain. It appears to be formed by the successive blending of cumuli, inlaced by streaks of dark stratus. The thunder-cloud is one modification of this species. It often assumes a portentous size, and is contorted into singular forms. Its indications are not uniform. When it appears in the morning, the day is often dry, though overcast; but when much mixed with stratus, it indicates approaching rain, after some interval.

The nimbus is a shower seen in profile as it approaches the spectator from the horizon. The thunder-cloud, on the discharge of its electricity, generally passes into the nimbus.

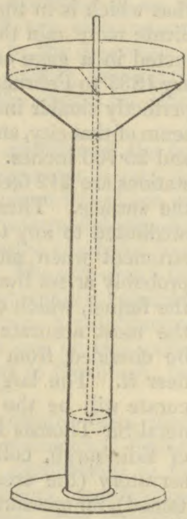
Mists or *Fogs* are but the condensation of invisible vapour into minute drops of water. They are generally more stationary on the sea than on the land. They are less frequent in the day than the night, in hot than in cold climates; and they are frequent in approaching the poles. One of the most remarkable stationary fogs is on that part of the Atlantic called the *Banks of Newfoundland.* The warm waters of the gulf-stream, after sweeping along the shores of the United States, and warming the superincumbent air, are encountered at Newfoundland by the polar currents, and the colder air over them. The consequence of this intermixture of the aerial currents at different temperatures, is the diminished capacity of the mixture for moisture, and the consequent deposition of a portion of its vapour in the form of mist. When the cold producing condensation of atmospheric moisture is intense, instead of mist, a deposition of minute particles of ice may take place, and will cover with delicate crystallizations the hair and clothes of the traveller, or the twigs and branches of trees. When the air is saturated with moisture, sudden condensation assumes the form of

Rain.—Amongst the numerous speculations on the production of rain, one of the most ingenious is that proposed by Dr James Hutton. He evidently considered the water as *dissolved* by the air; but if we merely consider the term "complete saturation with moisture" as meaning the dew-point, and the quantity suspended by air as indicating the quantity of vapour existing in the atmosphere at a given temperature by its own elasticity, this phraseology will produce no error. Hutton ascribed rain to the intermingling of air saturated with moisture at different temperatures. His views were communicated to the Royal Society of Edinburgh in 1787; but, from his contenting himself with a mere enunciation of his theory, it has been scarcely noticed by meteorologists, until illustrated in the articles METEOROLOGY and HYGROMETRY. Sir John Leslie has shown, that the mere commixture of air at different temperatures would produce but a small part of the effect perceived. It is proved by experiment that the capacity of air for moisture, or the quantity of vapour in a given space, increases in a much higher ratio than the temperature; and hence, if the space occupied by the mixture of masses of moist air, at different temperatures, have the mean temperature of the mixture, or one below it, a deposition of moisture or of rain will follow; but the whole effect would be smaller than what is often observed to take place, unless we suppose that two currents of air are moving, with considerable velocity, in opposite directions.

The objection to this simple view of the question is, that there are often heavy falls of rain when the clouds emitting it are evidently in very slow movement; and we have long believed, that without calling in the aid of electricity, as already stated when treating of the formation of clouds, no theory of rain will be satisfactory.

The hygrometric water in the air seems to owe its suspension to the repulsions among the electric atmospheres of its particles: when that electricity is withdrawn by any cause, the particles of water, no longer kept asunder by their electricity, coalesce, and descend by their gravity with a force proportional to their quantity and the reduction of their electric tension. If the electric fluid be slowly withdrawn, there is neither lightning nor any explosion; but if the accumulation has been great, and the abstraction sudden, we have the phenomena of thunder and lightning. On this view, evaporation is to be considered as the grand mode by which the atmosphere acquires electricity, and the accumulation seems in general in proportion to the intensity and duration of the evaporation. Hence lightning is most common and vivid in warm latitudes; and there is seldom any considerable electric discharge from the atmosphere, without a concomitant fall of rain, which is usually proportional to the violence of the thunder-storm.

No. 21.

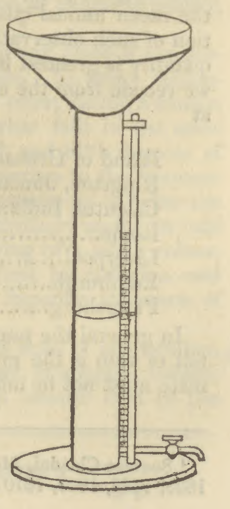


Rain falls in drops of a size varying from $\frac{1}{25}$th to $\frac{1}{3}$d of an inch in diameter; and it has been calculated that their ultimate velocity is in the duplicate ratio of their diameters. When formed high in the atmosphere, or passing through very cold strata of air, they congeal into hail or into snow.

Ombrometers.

To ascertain the quantity of rain which falls in any place in a given time, various species of *ombrometers* or *rain-gages* have been employed. The most usual form of the gage is that represented in No. 21. It consists of a cylindrical vessel of copper, usually 3·75 of an inch in diameter. Upon its upper part, a funnel of the same metal, with an upright brim exactly one foot in diameter, is fitted; a hollow vessel of metal, or a piece of cork, serves as a float, to support a rod of boxwood graduated in tenths of an inch. The water which falls into the funnel finds its way into the cylinder, and raises the float. The quantity is read off the rod at a stay placed across the funnel, and from the relative proportion of the cylinder and funnel, each $\frac{1}{10}$th of an inch is equivalent to $\frac{1}{100}$th of an inch of water entering the mouth of the funnel.

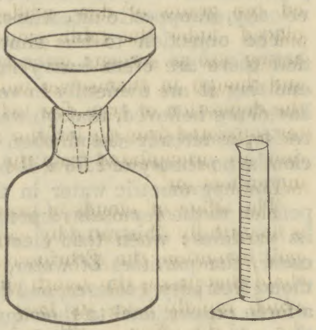
No. 22.



Another very convenient form is represented in No. 22., where the height of the column of water in the cylinder is seen in a glass tube connected with the cylinder below. A scale is applied, as in the figure; and when the observation is made, the water is let off by the stop-cock.

Mr Luke Howard's rain-gage is seen in No. 23. The funnel is fitted on the neck of a glass bottle, by means of an exterior tube, which is soldered to the funnel, and prevents the entrance of water into the vessel, except through the mouth of the funnel. The quantity of rain is ascertained by a graduated glass measure, the divisions of which correspond to 100ths of an inch, falling on the mouth of the funnel. This same measure will serve to ascertain the quantity evaporated in a given time, provided the mouth of the vessel, No. 20, is exactly equal to the mouth of the rain-gage.

No. 23.



Their position.

There are considerable practical difficulties in the proper position of a rain-gage. It is found, that if one be placed on the ground, and another on the top of a building, that which is in the lowest position will almost always indicate more rain than the upper. Thus, the quantity collected in a gage on the top of York Minster, from February 1833 to February 1834, only equals 14·963 inches, while perfectly similar instruments placed on the top of the museum of that city, and on the ground, gave relatively 19·852, and 25·706 inches. The elevations of the first and second stations are 212 feet 10½ inches and 43 feet 8 inches above the surface. These differences are too considerable to be attributed to any thing but some imperfection in the instrument when much exposed to gales of wind; and it probably arises from eddies being formed round the rim of the funnel, which divert part of the water. On the whole, the most accurate estimate of the quantity of rain will be obtained from instruments placed on the ground, or near it. The larger the recipient surface, the more accurate will be the indications; and on this principle, General Sir Thomas Brisbane, president of the Royal Society of Edinburgh, collects the rain from the roof of his observatory (the area of which has been accurately ascertained), for measuring the quantity of rain which falls in his vicinity.

Quantity of Rain.

When the quantity of rain which falls at any place has been regularly kept for several years, it is easy to obtain the mean annual quantity at that place. The multiplication of such observations has proved, that the mean annual quantity is greatest in tropical climates, and diminishes as we recede from the equator. Thus, the mean annual rain at

		Inches.
Island of Granada,	lat. 12°	=126
Kingston, Jamaica,	lat. 18°	= 83
Calcutta, India	lat. 22° 23′	= 81
Rome	lat. 41° 54′	= 39
Liverpool	lat. 53° 22′	= 33
Edinburgh	lat. 55° 57′	= 24
Petersburg	lat. 59° 56′	= 16

In general the number of rainy days is least where the fall of rain is the greatest, and the dampness of any climate must not be inferred from the annual quantity of rain. A country may be involved in almost perpetual fogs, or have many days of drizzling rain, in which the number of inches of rain throughout the year may be very small.

The quantity of rain, however, depends upon other circumstances than the latitude. It is much influenced by the vicinity of mountains in every climate. Thus,

	Inches.
At Kingston, on the shores of Jamaica, it	= 83
In Caraib country, among the mountains there	= 97
In Demerary, in the swamps of Guyana	= 73
In the lofty island of Granada	=126

Yet in Demerary as much as six inches of rain have been observed to fall in twelve hours. Similar observations occur in our own country.

	Inches.
At Carlisle the annual rain	=34
At Whitehaven	=52
At Kendal	=56
At Langside, near Glasgow	=37
At Carbailly, in Stirlingshire	=46
At Ardincaple	=50
At Lochlomond	=52
At Castle Toward, Argyleshire	=56

In Great Britain, it is generally found that much more rain falls on the western than on the eastern coasts. Thus,

	Inches.
At Edinburgh the rain	=24
At Elgin	=24
At Garnet Hill, near Glasgow	=32
At Greenock	=39

The latter town lies in a sheltered nook, or perhaps its annual quantity would have been higher; for,

	Inches.
At Catrine House, in Ayrshire, it	=45
And at Lanfine House, ditto	=52

It is scarcely necessary here to dwell on various extraordinary substances which have sometimes fallen from the air. *Showers of sulphur* have been mentioned by different observers. Wormius records such a shower as occurring at Copenhagen in May 1646; but the same phenomenon occurred in May 1804; and the philosophers of our own age, on analyzing this deposit, recognised it to consist of a vegetable pollen, resembling the powder of *lycopodium.* This substance fell in the night time, and, being phosphorescent when observed, gave considerable alarm. At Bordeaux, in 1761, a shower of a yellow powder was observed, which, however, was recognised as the pollen of the pine forests in the neighbouring *landes,* carried up into the air by a violent gale. Of a similar nature, in all probability, was the *yellow rain* which covered the Lake of Zurich in 1677.

The supposed *showers of blood* which have been recorded in some ancient chronicles are now ascribed to the same source as the red snow of Greenland and the Alps, that is, to the red globules or seeds of the *uredo nivalis;* or to minute red insects, which are sometimes carried down in great quantity with rain. The appearance of drops of blood falling from the air has occasionally been produced by the red excrement of insects. That small frogs and fishes have occasionally descended with rain has been admitted, as such animals, and even much more ponderous matter, have been elevated into the atmosphere by whirlwinds.

The showers of stones which have been noticed by several ancient writers as happening in Italy, Greece, and Asia Minor, are now believed to belong to the class of facts described under the article METEOROLITE.[1] These are mineral bodies, which, however they find their way into the atmosphere, have undoubtedly fallen upon the earth; and, however remote the places in which they descend, they are all distinguished by one remarkable similarity, viz. their containing an alloy of iron and nickel, generally with twenty-five of the former to six or eight of the latter.

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[1] See also Chladni, *Mémoire,* in *Journal de Physique;* Howard, in Phil. Trans. 1802; *Bibliothèque Britannique,* 1803; Nicholson's Journal, 1803, 1805, 1809, 1810; *Annales du Muséum d'Hist. Nat.* 1803; Izarn's *Lithologie Atmosphérique,* Edin. Phil. Journal, vol. i.

Dew.—The phenomena and cause of this deposition have engaged the attention of philosophers from the time of Aristotle; but their speculations present little that is satisfactory until the experimental investigations of Dr Wells. One of the most remarkable circumstances attending the deposition of dew is, that the bodies on which it is found have invariably a lower temperature than the ambient air, as was first pointed out by Dr Patrick Wilson of Glasgow, who ascribed the coldness to the deposition of dew; but Dr Wells has proved that the cooling of these bodies below the temperature of the air always *precedes the formation of the dew*, and is, in fact, the cause of this aqueous meteor. His theory is founded on Leslie's view of the heat which is sent off from the earth toward a clear sky; and on this simple principle Wells has been enabled to give a satisfactory explanation of the phenomena of dew.

The essential requisites for the deposition of dew are five in number, viz.

1. An atmosphere replete with moisture. As dew is a deposition of water from the air, it obviously must be in excess ere it is deposited. In Egypt, the south winds, blowing over extensive tracts of sandy desert, deposit no dew; but when the *Etesian* or north wind blows, loaded with moisture from the Mediterranean, the deposition of dew in lower Egypt is sufficient to soak through the garments of the inhabitants; and in the arid plains of New Castille the dews are far less copious than on the coasts of Andalusia.

2. There must be a considerable difference between the temperature of the earth in the night and the day. Other things being the same, the deposition is greatest when a cool evening succeeds a sultry day. In our climate, the dews are most abundant in spring and autumn, when the difference of temperature is greatest; but as the ratio of the increase of moisture in the air is greater than the increase of heat, hot climates have more copious dews than Great Britain, even though the difference between diurnal and nocturnal temperature be less in the former. Thus we have found the dews in the south of Spain, and in Marocco, far more copious than here; a short exposure about sunset in those countries completely soaking one through the clothes.

3. But the most essential requisite for the deposition of dew is, that the bodies upon which it forms should have their temperature considerably lower than that of the ambient air. In repeating Wilson's experiments, Dr Wells found that all bodies on which dew formed were colder than the air by 10° or 15°. Thus, in clear weather, he observed that a thermometer laid on grass was 12° lower than one laid on mould, and sixteen and a half below one on a gravel walk. He always found that the coldness of the body preceded the deposition of dew; and this is illustrated by the deposition of moisture which immediately takes place on pouring into a glass cylinder, placed in a warm, moist room, very cold water.

4. A serene and cloudless sky is also very favourable to the formation of dew. Wells found, that although the atmosphere be in other respects favourable to the deposition, yet little or none is formed if the sky be veiled in clouds; and, in such cases, the temperature of objects on the surface was near that of the air. He points out how clouds act as a screen to intercept the emanations between the earth and the upper regions of the air, which are well known to be the abodes of perpetual congelation. The same effect was produced by interposing screens of an opake material between the sky and the surface of the earth. Thus a thermometer, laid on a table, indicated a lower temperature than one placed on the ground under the table; and a lock of wool laid on the table collected ten grains of dew, whilst an equal weight of wool placed under the table gained only two grains. Fogs, acting also as screens, intercept the influence of the sky; and though in themselves moist, they are unfavourable to the deposition of true dew, which may be regarded as water separated from the inferior stratum of air; but fogs, like rain, are precipitated from the general mass of the superincumbent air.

The effect of clouds in preventing the radiation of heat is beautifully illustrated by carrying Professor Leslie's elegant invention, the Æthrioscope, into the open air. Every cloud that passes the zenith affects this delicate instrument, which rapidly loses its heat when exposed to the clear sky; or the effect is still more conspicuous if the operator hold a parasol, and alternately extend the æthrioscope beyond the shade and withdraw it under the parasol.

5. Serene and calm weather is favourable to the formation of dew; a fact which had been noticed by Aristotle. The influence of wind seems to depend on the rapid succession of aerial particles preventing the full influence of the cooling medium on the general temperature of an inferior stratum of the atmosphere. Every circumstance which favours radiation is favourable to the deposition of dew, such as a rough surface, and dark colour; proving the dependence of dew on the cooling of the objects on which it is deposited.[1]

Honey and jelly dew.

Dew often partakes of the sensible qualities of the bodies upon which it is found; hence dew-water is very apt to putrefy. Some substances found on plants have been erroneously confounded with dew. What is termed *honey-dew* generally owes its qualities to the saccharine exudation from the bodies of the insects called *Aphides*. The *jelly-dew* is believed to be the original form of a cryptogamian vegetable production, the *Tremella nostoc* of Linnæus; a membranous, pellucid, greenish-yellow matter, about one or two inches in width, which is at first moist and soft to the touch, but dries into a blackish membrane.

Snow.

Snow.—When the congelation of moisture takes place slowly, the flakes of snow assume very symmetrical figures, the varieties of which have been well represented in the work of Scoresby. They usually present modifications or combinations of the hexangular prisms, often consisting of a star of six rays, formed of prisms united at angles of 60°; and from these other prisms shoot, at similar angles,[2] giving the whole a plumose appearance, of exquisite beauty, and often of surprising regularity.

The quantity of snow which falls in any place is not proportional to the height of its latitude. In many temperate countries, the successive falls of snow, during a winter, may often greatly exceed in depth what falls in the same period in countries between the 65th and 80th degrees of latitude. In fact, it bears some proportion to the evaporation in countries where the winter temperature is below the freezing point of water. Snow is extremely useful, in cold climates, as a loose and spongy covering of a white colour, in preventing the loss of terrestrial heat by radiation, and in defending the surface from the frigorific influence of very cold winds.

Hail.

Hail differs from snow chiefly in its state of aggregation, and its far less regular crystalline form. It appears, indeed, to be the production of sudden and intense cold in the higher regions of the atmosphere, and therefore often occurs in warm climates, where snow is utterly unknown. A hail shower is often ushered in by a rattling noise, heard over head, before almost any hailstones have reached the ground. The ordinary size of hailstones with us varies from $\frac{1}{10}$th to $\frac{1}{3}$d of an inch in diameter. Occasionally they are much larger; as in the remarkable hail-storm described by Dr Neill, which occurred during a thunder-storm in the Orkneys on the 24th of July 1818.[1] Mingled with ordinary hail were enormous masses of ice, some as large as the egg of a goose; by which animals were killed, and individuals wounded. An enormous hailstone is recorded to have fallen, amongst many very large masses, at Handsworth House, near Birmingham, during a thunder-storm, on the 8th of June 1811. It consisted of a cuboidal mass $6\frac{1}{2}$ inches in diameter; and, from the engraved sketch, it resembled a congeries of frozen balls about the size of walnuts. On the Continent of Europe, the large hail of summer is frequently exceedingly destructive to vineyards; and in some districts of France, where the damage has often been great from thunder-storms, accompanied by large hailstones, the ingenious device of the *Paratonnerre* has been employed to prevent the accumulation of electricity over these valleys. The contrivance consists in the erection of pointed electric conductors on the surrounding hills, by which the lightning is silently and gradually abstracted from the air, and dangerous accumulations over the included districts generally prevented. In hot climates, the descent of large masses of frozen water is still more common than in Europe, especially within the *Calms* off the western coast of Africa.

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[1] Wells's Essay on Dew, London, 1814.

[2] Scoresby's Arctic Regions, vol. i.

Winds.

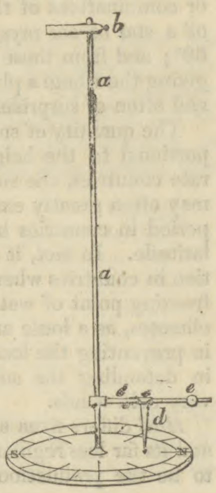
Winds.—The influence of mechanical causes in producing those aerial currents termed winds has been generally admitted, from the ages when they were poetically imagined as viewless forms, imprisoned or let loose from the caverns of Æolus, to the present day, when they are considered as the consequences of partial changes in the density of the atmosphere, arising from the unequal distribution of heat over the surface of the globe, or from alterations on its hygrometric and electric states. But the manner in which their force and direction are affected by these circumstances, in those sudden and local storms which frequently agitate the air, is difficult of explanation, although the general phenomena may admit of a very probable solution.

Register anemoscopes.

The dependence of the weather on the direction and force of the winds has given rise to many inventions for indicating their variations. The direction is shown by the well-known vane, or simple *anemoscope*, the movements of which are referred to the cardinal points by a fixed index, or by a plate marked with the rhumbs of the mariner's compass. To save the trouble of frequent daily observations, the labour of the meteorologist may be materially abridged by the following methods of obtaining *maxima* and *minima* of the direction of the winds.

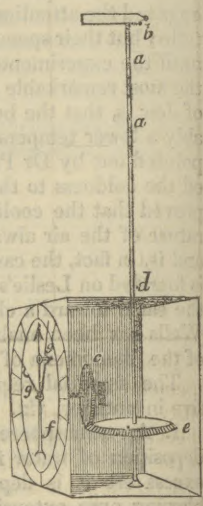
In the first, No. 24, the vane *b*, fixed to the axis *a*, causes the latter to revolve in a socket, in the centre of a writing slate marked with the rhumbs of the compass. The arm *c*, jointed to it, carries a pencil *d*, which records the progress of the vane on the slate. The pressure of the pencil may be regulated by sliding the ball *e* on the arm; and, to diminish friction, the socket consists of a flint, with a smooth hollow cavity, and the axis is kept perpendicular by moving between friction rollers.

No. 24.



In the second, No. 25, the same effect is shown on a vertical dial, by converting the horizontal motion of the vane into a vertical movement of the index. This is produced by one bevelled wheel *e* on the axis of the vane, and a similar one *c* on the axis of the index *f*. The *maxima* and *minima* are shown by two moveable arms *gg*, concentric with the index, but pushed to either side by a stud on the lower surface of the index. These instruments, devised long ago by Traill, and published in Professor Jameson's Journal for 1837, sufficiently answer the object for which they were intended.

No. 25.

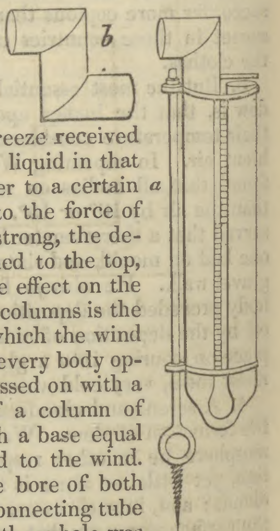


Anemometer.

The varying force of the wind is ascertained by the *anemometer*. The principle of several such instruments is the direct pressure of the wind on a given surface, kept by a vane perpendicular to the direction of the breeze. Sometimes this pressure is measured by raising a weight; in some instruments by the degree of compression of a spiral spring; or, as in the ingenious anemometer of Mr Waddel of Leith, by the compression of a slender cylindrical bag filled with quicksilver, and connected with a vertical tube one foot in length, with a bore of $\frac{1}{20}$th of an inch. The force of the wind is estimated by the height of the column of mercury. A practical difficulty arises from the quickness of the oscillations, which renders it not easy to read off the indications of the instrument during a smart gale.

The same objection in some measure applies to the elegant pocket anemometer of Dr Lind. It consists of two equal glass tubes, united below by a narrow connecting piece, as in No. 26, and having between them a scale of equal parts. The tubes are filled to the middle with water; and as the instrument is made to revolve freely round the iron spindle *a*, its body acts as a vane, to keep the orifice of the kneed brass tube always directed to the wind. The breeze received at that aperture depresses the liquid in that limb, and raises it in the other to a certain point on the scale, according to the force of the breeze. When it is very strong, the detached piece of brass *b* is joined to the top, and an allowance made for the effect on the column. The sum of the two columns is the height of a column of water which the wind is capable of sustaining; and every body opposed to that wind will be pressed on with a force equal to the weight of a column of water of that height, and with a base equal to that of the surface exposed to the wind. In the original instrument the bore of both legs = $\frac{4}{10}$ths of an inch, the connecting tube was $\frac{2}{10}$ths, and the length of the whole was six inches. Lind gave the following table as its indications.

No. 26.



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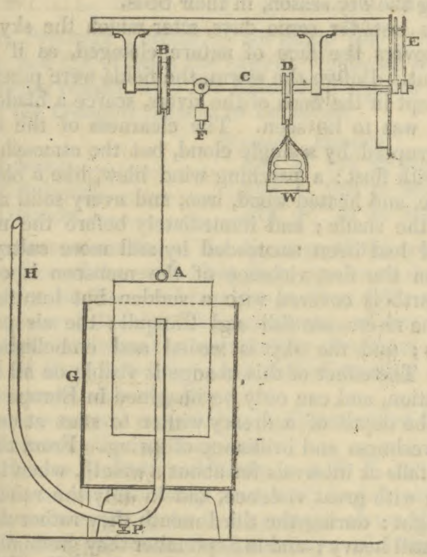
[1] Edinburgh Philosophical Transactions, vol. ix.

Height of Water in the Gage.	Force of the Wind on One Foot Square, in lbs. avoirdupois.	Common Designations.
12 inches.	62·500	
11	57·293	
10	52·083	Most violent hurricane.
9	46·875	
8	41·667	Very great hurricane.
7	36·548	Great hurricane.
6	31·750	Hurricane.
5	26·041	Very great storm.
4	20·833	Great storm.
3	15·625	Storm.
2	10·416	Very high wind.
1	5·208	High wind.
0·5	2·604	Brisk gale.
0·10	0·521	Fresh breeze.
0·05	0·260	Pleasant wind.
0·025	0·030	Gentle wind.

This instrument is, upon the whole, the most convenient anemometer we possess, and has the advantage of portability. The oscillations of the liquid might be farther checked by twisting spirally the tube of communication, as in the marine barometer.

A very ingenious anemometer has been constructed by Mr Richard Adie, late of Edinburgh, now of Liverpool. An index E is moved by the rising and falling of a cylinder A, closed at one end, and inverted in a larger cylinder G, containing water, on the principle of a gasometer for chemical experiments. The inverted vessel is suspended by a cord passing over a pulley B fixed on the axis C of the index. The counterpoise is a weight W, the cord of which, wound on a fusee or snail D, equalizes the counterpoise in the different positions of the internal cylinder. The influence of the wind on the instrument is produced through a tube, as in the figure. One end terminates in the interior cylinder, and the other in a kneed tube moving freely round by means of the attached vane. A very gentle breeze is sufficient to elevate the cylinder, and the revolution of the index marks the comparative force of different winds. This anemometer has been found to act well, and has been put up at several of the northern lighthouses.

No. 27.



The last anemometer we shall notice is that invented by Professor Whewell, who exhibited it to the British Association. It consists of a small *wind-wheel* of eight vanes, directed to the wind by an attached vane. By a train of toothed wheels and endless screws, the rapid revolutions of the wheel are converted into a slow vertical motion, by which a pencil is made to trace a downward line on the surface of a vertical cylinder having the same axis as the vane. The length of this line records the whole amount of the aerial current that passes over the place of observation, and the part of the circumference of the cylinder on which the trace appears indicates the direction of the winds. Three of these instruments are, by direction of the Association, on trial in different places, and the results will be communicated in the present year (1838).

Force of the wind.

In Smeaton's valuable paper upon the moving power of wind and water (Philosophical Transactions, vol. li.) there is the following table of the force of the wind, calculated by his friend Mr Rouse; which the celebrated engineer considers as entitled to confidence, especially in velocities below fifty miles per hour.

Velocity of the Wind.		Perpendicular Force on an area of One Foot, in lbs. avoird.	Common Designations of the Winds.
Miles per Hour.	Feet per Second.		
1	1·47	0·005	Hardly perceptible.
2	2·93	0·020	Just perceptible.
3	4·40	0·044	
4	5·87	0·079	Gentle breezes.
5	7·33	0·123	
10	14·67	0·492	Pleasant brisk gales.
15	22·00	1·107	
20	29·34	1·968	Very brisk gales.
25	36·67	3·075	
30	44·01	4·429	High winds.
35	51·34	6·027	
40	58·68	7·873	Very high winds.
45	66·01	9·963	
50	73·35	12·300	A storm or tempest.
60	88·02	17·715	A great storm.
80	117·36	31·490	A hurricane.
100	146·70	49·200	A great hurricane.

The third column is calculated according to the squares of the velocities of the wind, which Smeaton considers as generally correct.

Trade-winds.

Trade-winds.—In those portions of the Atlantic and the Pacific Oceans between the tropics, the wind has, throughout the year, a direction from the *east.* The following explanation agrees pretty well with the facts. The dense cool air of the polar and temperate regions naturally tends to displace the lighter warm air over intertropical regions, which, heated by the sun, produce vertical movements in the superincumbent atmosphere. Hence the ascending current of warm air between the tropics has its place supplied by the denser air from either side; and thus two currents are set in motion, from the poles towards the tropical regions. The velocity of every point on the earth's surface increases from the poles to the equator. But as the particles of these currents cannot at once acquire a velocity equal to the continually accelerating velocity of the parts of the earth's surface over which they arrive in this transit, the northern and southern currents will gradually seem to acquire a motion in an opposite direction to that of the rotation of the earth, that is, both will gradually decline to the west, assuming in the northern hemisphere the character of a N. E., and on the south side of the line of a S. E. wind; whilst both will become more *easterly* as they approach the equator. This effect of the augmenting velocity of the earth's surface, in approaching the equinoxial line, is increased by the continual movement of the point over which the sun is vertical, and consequently his heat the greatest, to the west; and the effect of the gravitation of the sun and moon on the atmosphere, as was shown by D'Alembert, must directly tend to increase the force of the easterly wind. The influence of these luminaries on our atmosphere is corroborated by the observations of Bacon, Halley, and Gassendi, on the frequency of storms about the equinoxes, or at full and new moon, and the general occurrence, in calm weather, of light airs of wind at the time of high water. When these causes are not counteracted by the superior rarefaction of air over land heated by the sun's rays, the easterly winds blow with much regularity, as in the great oceans; and, from their important influence on navigation, they have obtained the denomination of *trade-winds.* They extend to about 30° on each side of the equator; but, from the less density of the atmosphere in the northern hemisphere, arising from the greater quantity of land to be acted on by the sun's rays in that half of the globe, the line which marks the blending of the S. E. and N. E. trade-winds is between two and three degrees north of the equator.

If the surface of the globe had been one expanse of water, the trade-winds would have blown all round the equator, and the only other winds known would have probably been N. and S. winds near the poles, gradually bending from E. to W. as they approached the tropics. But the air over the land being much more heated by the sun's rays than that over the sea, the vicinity of large islands or of continents causes interruptions to the regularity of the trade-winds. Thus, on the coasts of Africa, within the regular limits of the trade-winds, *westerly* gales are not unknown; and a *southerly* wind prevails along the western shores of that continent, from Cape Palmas to the Cape of Good Hope; a consequence of the form and climate of Northern Africa, which continues the southern polar current far beyond its limits in the free ocean.

A similar cause appears to give rise to the *Calms* on that coast, from 10° to 4° N., a tract avoided by seamen, on account of these calms, and sudden alternations, with tremendous storms of thunder and lightning, to which it is subject. The general direction of the trade-winds is affected by their approach to the shores of America; they are expanded, chiefly owing to the resistance they meet with from the land, and also by the additional rarefaction of the air re-acting upon that continent. Precisely similar disturbances from the position of land produce

Monsoons.

The *Monsoons* of the Indian Ocean. The eastern trade-wind blows regularly in that sea between the parallels of 10° and 30° S.; but from these parallels northwards, or on the sea between Sumatra and Eastern Africa, the course of the trade-winds is reversed for half the year, from April to October, during which period there is a constant wind from the S. W. During the other six months the regular trade-wind, from the N. E., resumes its course. These winds are termed the S. W. and N. E. *monsoons*, from a Malayan word signifying *seasons.* The latter is produced by the same causes as the general trade-wind. The other appears to be occasioned by the great rarefaction of the atmosphere over the extensive regions of Eastern Asia when the sun is north of the equator, and the dense air of the Indian Ocean rushes in to occupy the place of the ascending current.

This disturbance of the trade-wind is attended with very remarkable effects on the climate of the country where it prevails. It is the harbinger of the rainy season in India, which is ushered in by violent thunder-storms. A most striking picture of this change of monsoon is given by Mr Elphinstone in his Account of Caubul. "The most remarkable rainy season is that called in India the S. W. monsoon. It extends from Africa to the Malayan peninsula, and deluges all the intermediate countries, within certain lines of latitude, for four months in the year. In the south of India this monsoon commences about the beginning of June, but it gets later as we advance towards the north. Its approach is announced by vast masses of clouds, that rise from the Indian Ocean, and advance towards the N. E., gathering and thickening as they approach the land. After some threatening days, the sky assumes a troubled appearance in the evenings, and the monsoon in general sets in during the night. It is attended by such a thunder-storm as can hardly be imagined by those who have only seen that phenomenon in a temperate climate. It generally begins with violent blasts of wind, which are succeeded by floods of rain. For some hours lightning is seen almost without intermission; sometimes it only illumines the sky, and shows the clouds near the horizon; at other times it discovers the distant hills, and again leaves all in darkness; when, in an instant, it re-appears in vivid and successive flashes, and exhibits the nearest objects in the brightness of day. During all this time the distant thunder never ceases to roll, and is only silenced by some nearer peal, which bursts on the ear with such a sudden and tremendous crash as can scarcely fail to strike the most insensible heart with awe. (Malabar is the province most distinguished for the violence of the monsoon.) At length the thunder ceases, and nothing is heard but the continued pouring of the rain, and the rushing of rising streams. The next day presents a gloomy spectacle; the rain still descends in torrents, and scarcely allows a view of the blackened fields: the rivers are swollen and discoloured, and sweep down along with them the hedges, the huts, and the remains of the cultivation which was carried on during the dry season, in their beds.

"This lasts for some days, after which the sky clears, and discovers the face of nature changed, as if by enchantment. Before the storm, the fields were parched up, and, except in the beds of the rivers, scarce a blade of vegetation was to be seen. The clearness of the sky was not interrupted by a single cloud, but the atmosphere was loaded with dust: a parching wind blew, like a blast from a furnace, and heated wood, iron, and every solid material, even in the shade; and immediately before the monsoon this wind had been succeeded by still more sultry calms. But when the first violence of the monsoon is over, the whole earth is covered with a sudden but luxuriant verdure: the rivers are full and tranquil; the air pure and delicious; and the sky is varied and embellished with clouds. The effect of this change is visible on all the animal creation, and can only be imagined in Europe by supposing the depth of a dreary winter to start at once into all the freshness and brilliancy of spring. From that time the rain falls at intervals for about a month, when it comes on again with great violence, and in July the rains are at their height: during the third month they rather diminish, but are still heavy; and in September they gradually abate, and are often suspended till near the end of the month, when they depart amid thunders and tempests, as they came."[1]

Sea ar land b zes.

Sea and land breezes are occasioned by the same causes which produce the S. W. monsoon, and are chiefly experienced on tropical sea-coasts.

The sea-breeze commences about 10 A. M., and continues throughout the day, till towards 6 P. M., when it gradually dies away, and about eight in the evening is succeeded by a much fainter breeze from the land, especially in those islands which have considerable mountains. It is well known in Jamaica, but less so in the smaller Antilles, and scarcely at all on the flat coasts of America. It continues during the night, and usually dies away before six or seven in the morning; but it is much less regular in its periods than the sea-breeze. The latter, too, occurs in places where the land-breeze is quite unknown. An admirable description of these is contained in the voyages of Dampier, and given at length in the article METEOROLOGY. The sea-breeze is more or less felt on the coasts of all warm countries. We have had occasion to observe with what regularity the sea-breeze sets in from the S. W. during the summer at Gibraltar, and it blows with considerable force throughout the greatest part of the day.

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[1] Account of Caubul, p. 126.

The explanation of the sea-breeze is the rarefaction of the air by the heat of the land, and the rushing in of denser air from the sea to supply its place; and as the influence of the sun decreases, this breeze dies away. The land-breeze is chiefly produced by the descent of air from mountainous regions, flowing, by its gravity, towards the sea, over which the atmosphere is less liable to suffer extreme rarefaction and condensation than the air over the land.

In temperate climates the winds are far less regular than in tropical countries. The general causes which produce them act with less force and constancy; and the disturbing causes, such as the vicinity of land, alteration in density from moisture and dryness, act with more uncontrolled energy. The most prevalent winds in Great Britain are from the S. W., especially on the western side of our island. The Royal Society registers give the following average for the winds throughout the year at London.

S. W.	112 days.	S. E.	32 days.
N. E.	58	E.	26
W.	53	S.	18
N. W.	50	N.	16

Or, with Professor Playfair, if we group the S. with the westerly, and the N. with the easterly winds, we shall have the following results, from the Edinburgh register of Playfair, and the Glasgow register of Dr Meek.

	Westerly.		Easterly.	
London	233	+	132	= 365
Edinburgh	242	+	123	= 365
Glasgow	314	+	51	= 365

These determinations of the direction of the winds refer to the surface of the earth; but there can be no doubt that the direction of the aerial currents is often different in the upper regions of the air. The permanence of very elevated clouds, their occasional movements in directions opposite to those of the winds below, and the information obtained from aeronauts, all prove this point.

There are several remarkable modifications of the wind, which deserve notice in this place.

The *Sirocco* of Italy and Sicily is a S. E. or S. wind, which, heated on the sandy wastes of Arabia and Libya, becomes occasionally moist in its passage across the Mediterranean, and oppresses the inhabitants of Italy, Malta, and Sicily with excessive languor, and a sinking of their mental energies. When it sets in, it causes a very sudden and powerful rise of the thermometer, and is accompanied by a haze which obscures the pure sky of those southern countries; the sun appearing dimmed and shorn of his beams.

The *Solano* of Spain is only a modification of the Sirocco. We have experienced it as most oppressive on the eastern shores of Spain; and it is greatly detested by the natives, who gravely remark, that "no animals except a pig and an Englishman are insensible to the Solano." The Italian condemnation of a stupid work, "era scritto in tempo del Sirocco," is not more pointed than the Spanish adage, "no rogar alguna gracia en tiempo de Solano," not to ask any favour during the Solano; and both proverbs sufficiently indicate the belief of the people of southern Europe in the disagreeable qualities of the S. E. wind. We have observed fine dust deposited from the Solano or *Levanter* at Gibraltar, and to this we partly attribute the haze with which it is accompanied. If this dust be brought with the Solano from Africa, it is less surprising than the following instance of dust carried by the easterly wind into the Atlantic. On the morning of the 19th January 1826, when the Clyde East Indiaman was on her voyage to London, in latitude 10. 40. N., longitude 27. 41. W., her rigging was observed to be covered with an impalpable powder of a brownish colour, and on unfurling the sails at two P. M. to catch the breeze, they emitted clouds of dust, which had lodged in them during a strong gale from the E. and N. E. In this case the nearest land in that direction was about seven hundred miles distant.

Khamsin or Simûn.

The *Khamsin* of Syria, the *Samiel* of the Turks, and the *Simûn* of the Arabs, is well described by Volney. It is a wind in no degree poisonous, except in as far as it is dangerous from its extreme heat and aridity; qualities it derives from blowing over sandy deserts intensely heated by the sun. Denon states, that it is loaded with impalpable sand, which penetrates into the closest packages. These winds derive their Syrian name from their prevalence during the fifty days about the equinoxes. They produce difficult respiration, a shrivelled skin, and a distressing sense of heat. Volney compares the effect of them to the sensation produced by the hot air from a baker's oven. They sometimes blow in squalls, and in Egypt usually continue for about three days at a time. In that period vegetation is withered, the inhabitants shut themselves up in their houses or their tents; and the Simûn is dangerous to persons of a full habit, from the sudden entrance of this heated and parched air into the lungs. In the sandy deserts it is greatly dreaded; but fortunately its extent is not considerable, and it seldom lasts long. It has been well described by Chardin, Sir John Malcolm, and Badhia.

Harmattan.

The *Harmattan* of the west coast of Africa is of the same kind, and produced by the same causes. The extreme dryness of this wind has been mentioned by all observers. It usually blows from the Great Sahara towards the coast, from the N. E., and, like the Solano, Sirocco, and Simûn, is loaded with dust. The dust which fell on the vessel just mentioned was from a violent Harmattan. The only difference between the Sirocco and these other winds appears to be, that the Sirocco obtains some moisture in crossing the Mediterranean; but they all seem to be mere modifications of aerial currents produced by the same causes.[1]

Tornado, &c.

The *Tornadoes*, *Typhons* of the Chinese Seas, the *Ox-eye* of the Cape, and the *Hurricanes* of the West Indies, are violent and extraordinary agitations of the air, generally accompanied by thunder-storms, and usually of short duration. The destructive violence of the three first has been well described by several navigators; and of the hurricane which desolated Barbadoes in the year 1780 we have a short but good account by Sir B. Blane.[2]

Whirlwind.

The name of *Whirlwind* has been given to eddying currents, seemingly depending on electricity, which sometimes rage with surprising fury in particular spots, tearing up trees by the roots, and overthrowing buildings. The extent of the whirlwind is usually confined; and as it passes through a forest it has been observed to form a lane or long track of inconsiderable breadth. The singular columns of moving sand, described by Bruce as occurring in Africa, appear to have been the effect of whirlwinds, or probably analogous to the meteor termed a *Waterspout,* which seems to be decidedly an electrical phenomenon.

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[1] For an account of the Harmattan, see Norris in Philosophical Transactions, lxxi.; and Lind on Hot Climates.

[2] Edinburgh Philosophical Transactions, vol. i.

A curious account of waterspouts is contained in Michaud's *Mémoire* in the Transactions of the Academy of Turin, which has been translated in Nicholson's Journal (vol. i. 4to series). The conical pillar would appear to consist of condensed vapour, which often has the deep indigo-blue tint of the cloud from which it proceeds. As this column descends to the sea, the spot below it becomes agitated, and, according to some observers, the waters are bodily drawn up towards the cloud. But this opinion seems to be doubtful; for it is stated that the water discharged on the bursting of a waterspout is always fresh, and therefore any water derived from the sea must have passed into the air in the form of vapour. Besides, they generally dissolve merely into mist on touching the land.

Iris.

On the luminous meteors which appear in the air our space will not permit us to expatiate. The *Iris* is well known to be produced by the refraction of white light by the spherules of water in a cloud, as has been beautifully and satisfactorily demonstrated by Newton. The explanation of the single and the double iris will be found in every treatise on natural philosophy.

Aurora.

The *Aurora Borealis,* and the similar luminous *Southern Meteor,* are still objects of doubtful origin. The brilliancy of the colours is subject to periodical increments and intervals of decline; and, after a considerable period of obscuration, it has, within the last few years, again begun to blaze forth with increasing splendour. We have seen all the prismatic colours present in an aurora; and many years ago, in the Orkney Islands, we were enabled at midnight to distinguish letters of a large print by its light. From the distance to which the same aurora has been seen, the meteor must often be very high above the earth, perhaps in the utmost limits of our atmosphere; but at other times it appears to be nearer to the earth, and we have persuaded ourselves that we have heard a noise accompanying the sudden coruscations of a brilliant aurora.

Halo and parhelion.

The *Halo,* the *Parhelion,* and *Paraselene,* are optical phenomena produced by refraction of light by vapour, or minute spicula of ice floating in the air. Parhelia have been described by Scheiner, Gassendi, Delahire, Cassini, Halley, Muschenbroeck, and Epinus.[1]

Lightning has been considered, with other electrical phenomena, under ELECTRICITY. The identity of lightning with common electricity, as excited by the *machine,* was so completely established by the celebrated Franklin, that no doubt has since existed on the subject; and the recent discoveries of Oërsted and Seebeck have indicated a close affinity between the phenomena of electricity, heat, and magnetism. As the electrical state of the atmosphere is an important subject of inquiry, we beg leave to recommend to the philosophical traveller some instrument for ascertaining this quality of the atmosphere; and perhaps no better portable electroscope has yet been devised than the pocket instrument of Cavallo.

Bolis, St Elmo's fire.

The *Bolis, St Elmo's Fire, Castor and Pollux* of the ancients, appear to be electric meteors. The former we have twice seen. The last time was on the 18th of September 1835, at eleven P. M., when at sea. The head appeared an elliptical ball of the most intense, brilliant, bluish-white light; the train had a tint of azure mixed with reddish, which sufficiently distinguished it on the clear sky; and sparks proceeded from its tail. Its motion was nearly horizontal, from S. W. to N. E., at a considerable height. It was visible for five or six seconds, and disappeared in a dense cloud. It was observed by four gentlemen standing together on the deck, and we thought that it emitted a crackling noise as it proceeded, with a majestic uniform movement.

No. 28.

Shoo star.

The more common meteor, the *Shooting Star,* as it is vulgarly termed, seems to be an electrical ball of fire, at a considerable height in the atmosphere. Its general course is from the zenith towards the horizon, which it seldom appears to reach.

Ignis fatu

The *Ignis Fatuus,* or *Will o' the Wisp,* is a meteor which apparently is connected with decaying animal or vegetable matter; and probably is produced by the disengagement of phosphuretted hydrogene. It is frequently seen in boggy grounds, as a flickering, unsteady light, in irregular motion. It sometimes plays over dunghills; and has occasionally, to the extreme terror of the ignorant, appeared as a lambent flame in church-yards. Dr Derham saw it once playing about a dead thistle. The most extraordinary meteor of this kind is that described by Signor Beccari, in the Philosophical Transactions (vol. xxxvi.). In the low grounds to the north and east of Bologna, *ignes fatui* of remarkable splendour were at that time seen almost every dark night. That in the fields of Bagnara, to the east of the city, was especially brilliant. It appeared and disappeared suddenly; it rose and fell, and often hovered about six feet from the ground; it sometimes contracted its volume, then expanded or divided into two; would again unite, and assume the form of a wave of flame; often it dropped bright scintillations, and occasionally threw as much light upon the road as a large torch.

The curious meteor described by Dr Shaw[2] as running along the ground, and playing on the ears and mane of his horse, has its counterpart, on a smaller scale, in other countries, and has often been witnessed in Britain. It seems in some instances to be an electrical meteor; but possibly it may also arise from the disengagement of phosphuretted hydrogene from living animals, or of a luminous and unctuous matter, like that of the glow-worm, or of phosphorescent marine animals.

A lambent flame has occasionally been observed to play around the heads of children, which has probably a similar origin; it has been finely described by Virgil, in his account of the glory that surrounded the head of the young Ascanius.

> Ecce levis summo de vertice visus Iuli
> Fundere lumen apex, tractuque innoxia molli
> Lambere flamma comas, et circa tempora pasci.
> *Æn.* ii. 682.

SECT. VIII.—*Climate.*

Climat

The temperature of the atmosphere is derived from the heating of that portion of it in contact with the ground, which has received and absorbed the incident solar rays. Whilst the earth revolves on its axis, successive portions of its surface are illuminated and heated by the sun; but the excessive accumulation of heat in any particular place is prevented by the abstracting power of the air, and by the radiation from the earth's surface which takes place during the night. These causes alone, however, could not have secured the diffusion of warmth over a large portion of the earth. Had the axis of the earth been perpendicular to the plane of its orbit, the same places would have had the sun always vertical; the equatorial regions would thus have been parched with intolerable heat; and much of what is now the fairest portions of the globe, the seats of literature and the arts, would have been doomed to sterility and desolation. The simple yet stupendous contrivance of the inclination of the axis to the plane of the orbit, by bringing successive portions of the northern and southern hemispheres alternately under the vivifying solar influence, has rendered the largest portion of the globe the abodes of animated beings; the fervour of a tropical climate is thus rendered less oppressive, and the limits of the temperate regions are greatly extended. The division into five *Zones*, and their denominations, give us a general idea of the temperature in each; but these are very inadequate to express the diversities of atmospherical temperature. Ancient geographers distributed the earth's surface into twenty-six parallel bands or *Climates*, which were supposed to indicate, with sufficient exactness, the differences of the heat of each region, until the invention of the thermometer gave more precise information.

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[1] See Priestley on Vision, and Muschenbroeck's Philosophy.

[2] Travels in Palestine and the East.

We have already stated how multiplied and careful observations may point out the mean temperature of any place, and the contrivances which have been resorted to for abridging the labour of the meteorologist; and philosophers have endeavoured to supply by calculation what is wanting in observation. The most ingenious of these speculators was Mayer of Göttingen. From an examination of such registers of temperature as he could obtain, he concluded "that the mean temperatures decrease from the equator to the poles, as the squares of the sines of latitude;" and therefore, if the mean temperature at the level of the sea under the equator were ascertained, this formula would enable us to calculate the mean temperature of any given latitude. Mayer applied his formula to the equatorial temperature as determined by Bouguer, = to 24° of Reaumur; but this has been found by Humboldt to be too high. It should have been only 22° of that scale, which is equivalent to 27°·5 of the centigrade, and to 81°·5 of Fahrenheit. With these corrections, Mayer's formulæ for the three thermometers, T signifying the temperature sought, will be

$T = 22^{\circ}\ {}^{2}\text{cos. lat.}$ for Reaumur.
$T = 27^{\circ}\cdot 5\ {}^{2}\text{cos. lat.}$ for Centigrade.
$T = 81^{\circ}\cdot 5\ {}^{2}\text{cos. lat.}$ for Fahrenheit.

Unfortunately, however, later observations have shown that Mayer's formula is worse than useless in high latitudes, and indeed is only found tolerably consistent with observation in latitudes between 40° and 60° N. The thermometrical registers of Scoresby, Parry, Franklin, and Ross, have proved that the mean temperature of the parallel between 70° and 75° is very far below what Mayer's formula would assign, and is even far below what that empirical rule would give to the pole. In low latitudes, too, it is not to be depended on; and it is totally at variance with the recent but well-established fact of *meridians of greatest cold.* No attempt of this kind has yet been found reconcileable with observation. In the mean time, the celebrated Humboldt has performed an acceptable service to science, by a more critical examination of the accumulated observations of his predecessors and contemporaries. The results he has given in his essay *on the Distribution of Heat over the Globe;* and the representation of them upon a chart of *Isothermal Lines* is peculiarly valuable, as deductions from actual observation. An inspection of such a chart shows, that these lines are neither parallel to the equator nor to each other. They are higher in Europe than at 100° to the E. or W. Thus the isothermal line of temperature 54°·5, in France passes through lat. 45° 46′; in China (long. 116° E.) it is in lat. 39° 54′; and in America, on the western coast (in long. 104° W.), it is in 44° 40′.

The isothermal lines descend lower in America than in Europe. Thus the line of 32°, or the freezing point, in Europe, lies in Lapland between 66° and 68°, but in America it passes on the coast of Labrador in lat. 54°; and this difference, which is small near the tropic, increases much with the latitude. Thus,

Lat.	Mean Temperature.		Difference.
	Old.	New.	
30°	70°·52 F.	66°·92 F.	3°·60
40	63 ·14	54 ·50	8 ·64
50	50 ·99	37 ·94	12 ·96
60	40 ·64	23 ·74	16 ·92

In both continents, the most rapid decrease of temperature takes place between lat. 40° and 45°. This circumstance has justly been considered by Humboldt as producing a happy influence upon the civilization and industry of the nations inhabiting these parallels; because there slight changes in latitude produce considerable diversity in the vegetable productions, which may become objects of rural economy; and when contiguous countries differ much in their products, it stimulates the industry of each, and gives vigour to commercial intercourse; circumstances highly favourable to civilization. The range of the thermometer is not the same under the same isothermal lines, as representing the mean temperature of the year. It is greater in the New than in the Old Continent. Thus, Cincinnati in America, and St Malo in France, are both on the isothermal line of 54°; yet the difference between the mean heat of summer and winter is 40° at the former, and but 32° at the latter. Even though the difference between the mean temperature of the seasons increase with the latitude, under the same meridians, yet the difference at Philadelphia in America, in lat. 40°, is much greater than at Copenhagen in Europe, in lat. 56°.

	Lat.	Mean of Summer.	Mean of Winter.	Difference.
Philadelphia. ...	40°	73°·94	32°·18	41°·76
Copenhagen.....	56	60 ·60	30 ·74	29 ·86

Effect of longitude.

The remarkable fact of the influence of *longitude* on temperature leads to the conclusion, that on each side of the equator there are two meridians, under which the mean temperature is lowest. These have been termed by Sir David Brewster the *cold meridians*, and their extremities are the *poles of greatest cold.* The position of these in the northern hemisphere may be approximated from recent investigations; and perhaps we shall not greatly err if we assign the longitude of 95° W. for the American, and of 100° E. for the Asiatic cold meridians. The apparent coincidence of the cold meridians with the general direction of Hansteen's lines of no variation is perhaps more than accidental, when we reflect that there seem to have been, in former ages, migrations of the cold meridians eastward and westward, coincident, as far as we can judge from recorded changes of climate in northern countries, with similar migrations of the magnetic needle.[1]

Effect of elevation above the sea.

Elevation above the sea is one of the most important circumstances by which climate is modified. As we ascend in the atmosphere the temperature diminishes, and under every latitude the summits of very lofty mountains penetrate into the abodes of perpetual congelation: such summits are covered with perpetual snows. The altitude at which this takes place varies with the latitude, diminishing from the equator to the poles. In climates where there is a great difference between the heat of summer and of winter, this point will fluctuate between two limits, one of which is the *upper*, the other the *lower limit of congelation.* The distance between them is least at the equator, and increases as we recede from it. This circumstance is important; for it influences the formation of those stupendous glaciers, that excite the astonishment of the traveller, on the elevated regions of the temperate zone, and on the declivities of the arctic circle.

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[1] Traill in *Mémoires de la Société de Physique et d'Histoire Naturelle de Génève*, tom. iv.

Sir John Leslie concluded, from some experimental investigations, that in moderate elevations we might estimate this decrease of temperature as we ascend, at 1° of Fahrenheit for every 300 feet of elevation; and he has given a formula for computing the point of congelation for every latitude; which, however, does not agree with observation in high parallels. The same remark applies to Kirwan's formula,[1] which presupposes a gradual depression of the point of congelation in receding from the equator. The requisite data for his calculations are the mean temperature at the level of the sea at the equator and at the given place, and the height of the equatorial point of congelation. Thus, if we take the point of perpetual congelation at Humboldt's estimate of 15,744 feet, and the mean temperature at the level of the sea there at 81°·5, the difference between that mean temperature and 32° will bear the same ratio to the equatorial point of congelation, as the excess of the mean temperature at the given place above the freezing point, to the point of congelation at the latter. Thus, if we wish to find the point of congelation in this latitude, 56°, we turn to a table of mean temperatures, and find it = 49° Fahrenheit.

Perpetual congelation.

$$81{\cdot}5 - 32 = 49{\cdot}5, \text{ and } 49 - 32 = 17, \text{ and}$$
$$49{\cdot}5 : 15744 :: 17 : 5407.$$

On this formula, then, 5407 feet would be the point of perpetual congelation in our climate; and had we any mountain exceeding that elevation, its summit would be covered with perennial snow.

We apprehend, however, that no formula will apply to all latitudes; and we know that Kirwan's does not agree with observation in high latitudes.

Effect of vicinity of the sea.

Even when the latitude and elevation of two places do not differ greatly, they may suffer very different extremes of temperature. The chief agent in effecting this is the ocean. It has been found that the proximity of the sea, in all climates, affects the extremes of temperature. When cold air sweeps over the surface of the ocean, the caloric of the upper particles is diminished, their density is increased, and they sink, while their place is supplied by fresh particles from below, which becoming cooled in their turn, give rise to internal motions in the ocean. As the law of *expansion* during cooling from 39° to 32°, which forms so singular an exception in the case of fresh water, does not take place in sea-water, there is nothing to arrest these internal motions in the ocean:[2] and from its enormous mass, it is obvious that no partial application of cold, in this way, can sensibly reduce its mean temperature. Hence we find that the temperature of islands is not in winter so low as that of continents in the same parallels. Thus the severity of winter in Britain bears no proportion to that of continental regions under the same parallel. The Orkney Islands are in the same latitude as St Petersburg; yet, in the former, a frost of a week's duration is a comparatively rare occurrence, whilst at the latter, the wide, deep, and rapid Neva is for several months annually frozen over.

On the other hand, the ocean exerts a great influence in mitigating the excessive heat of tropical climates. It is true, that when the upper particles of its waters become heated, the internal motions cease; but the rarefaction produced sets a current in motion to the west (as becomes apparent in the Gulf Stream), the place of which is supplied by the influx of cooler waters from either pole. This is not all. The increased temperature is mightily diminished by increased evaporation; a process by which as much caloric is absorbed as would be capable of heating an equal weight of water 942° Fahrenheit. Hence tropical islands are less oppressively hot than continents in the same latitude. The summer temperature of the smaller Antilles, for instance, is lower than that of the same parallels in America, Africa, or Arabia. The intersection of continents by arms of the sea, or by vast collections of water, tends to mitigate the fervour of summer. The extended form of the old continent toward the east renders inequalities of temperature much greater in Eastern Asia than under the same parallels in Europe. Thus, at Pekin, in latitude 40° N., longitude 116° 20′ E., the mean temperature of summer is 78°·8, and of winter 23°—a difference of not less than 55°·8, which gives rise to a frost of several months' duration in that part of China; yet Pekin is under the same parallel as the southern extremity of Naples, where frost is unknown, and of the central provinces of Spain, in which, though at an elevation of 2000 feet above the sea, ice is an extremely rare occurrence.

The face of a country, though less important than the circumstances already noticed, affects its climate. A region shrouded in primeval forests, or covered with swamps and marshes, will have a different temperature when cleared and drained. Marshes, by evaporation, rob the surface of much of its heat; and forests, by intercepting the sun's rays, the source of terrestrial warmth, and by the increased exhalent surfaces exposed to the air, undoubtedly have some effect on mean temperature. In hot climates forests tend to cool the air, and in frigid regions to prevent the loss of the earth's heat by chilling blasts. The clearing of forests may thus affect the temperature, and the draining of marshes increase the salubrity of particular regions; but the mere effect of cultivation can never be very considerable in changing a climate.

A combination of several of the causes already noticed as affecting climate have conspired to render the North American continent colder than the same parallels in Europe. Thus Nova Scotia and Canada, in latitude 47°, are in the same parallel as the central provinces of France and Upper Italy. In the former, the cold of winter has been observed as low as —40° Fahrenheit, or 52° below the freezing point of water; and the lakes and rivers of that part of America are bound up in impenetrable ice during four or five months of the year; while in the latter, in ordinary seasons, the severity of winter is scarcely felt. Labrador and England, each in latitude 53°, differ widely in mean temperature.

	Mean Temperature.		
	Summer.	Winter.	General.
Labrador...........	51°·8	3°·2	= 27°·5
England...........	62 ·6	37 ·4	= 50

The climate of America, however, should not be compared with that of Europe, but with the eastern side of the old continent. The eastern sides of both, from causes which perhaps are not easily explained, are certainly colder than the western; and when observations are multiplied on the western shores of America, it will probably be found that both continents approximate more nearly in mean temperature than the above comparisons would seem to indicate. In fact, the whole of Europe, as Humboldt has remarked, has an *insular climate* compared with the eastern parts of Asia and America; "and upon the same isothermal line the summers become warmer, and the winters colder, in proportion as we advance from the meridian of Mont Blanc to the east or to the west."[1] The eastern parts of China, and the Atlantic portions of the United States, have great differences between their summer and winter temperatures, or they are what Humboldt terms *excessive climates;* whilst all that we yet know of California, and of the country between it and the mouth of the Columbia, shows that the mean temperature of their winters and summers differs much less, and that they approach more nearly to the climate of Europe.

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[1] Essay on Climate.

[2] Dr Hope, Transactions of the Royal Society of Edinburgh.

The distribution of the land in high latitudes is not unimportant as regards climate. Land is more easily heated than water by the sun's rays; and where the icy barriers are in contact with land, there is a greater probability of their being melted by the heat of summer, than where the ice extends over a large surface of uninterrupted ocean. This seems to be one cause of the greater extent of the southern than of the northern polar ices.

Had the globe been uniformly covered by water, the progression of climate would probably have been very regular. Indeed it might be shown, that the effect of the polar currents produced by equatorial rarefaction, supposing them to move with a velocity of two miles per hour, or to make three annual transfers from the pole to the equator, would be sufficient to produce the variations of temperature which are experienced at the level of the ocean.

On the whole, the peculiarities of climate are chiefly attributable to latitude, elevation, the distribution of land and water, proximity to the cold meridians, the humidity or dryness of the air; to which we may add, though less important, the prevalence of particular winds, the transparency or cloudiness of the sky, and the state of the general surface of any country.

SECT. IX.—*Geographical Distribution of Plants.*

Whoever considers the vast accessions made to our list of vegetable species within the last twenty years, and the immense tracts of the earth still unexplored by scientific men, will readily conceive that we are yet in no condition to pronounce even as to the probable amount of the existing plants. In Professor Lindley's Introduction to Botany, the following is an approximation to known species.

	Phænogamous.	Cryptogamous.
Number of described species, according to Sprengel, in 1827...	31,000	6,000
Add for errors and suppression of real species	6,000	1,000
Add for India and the rest of Asia	10,000	2,000
Add for America	20,000	
Add for Africa	10,000	
	77,000	9,000

But if this afford a just estimate of the known species, it cannot give us any idea of the plants existing on the globe. Europe, with a surface $\frac{1}{9}$th that of Asia and Africa, and in some respects less favourable to a varied vegetation, has a flora more numerous than either, and, till within a few years, superior to both united. This can only be attributed to the greater diligence with which the botanic riches of Europe have been explored, and may lead us to suspect that we are yet far from a knowledge of all existing species.

While botanists considered plants only as belonging to artificial systems, the progress of geographical phytology was inconsiderable. Tournefort, in ascending Mount Ararat, had observed at its foot the plants of Western Asia; but a little way up he recognised the vegetable forms of Italy; at a still higher level, those of Central France; next those of Sweden; and beyond them the flora of Lapland and the Alps.

Similar remarks were occasionally made by other botanists in other regions. They had determined with considerable accuracy the northern boundaries of some plants, especially those useful to man; but whilst the method of grouping plants was merely artificial, the physical laws which regulate their distribution were not perceived, and the circumstances which limit certain vegetable forms to particular situations were not comprehended. Humboldt's essay on the geography of plants appeared at Paris in 1807, and contained some generalizations on the succession of vegetable forms in Equinoxial America; but it is admitted on all hands, that the disquisitions of Dr Robert Brown, in the Supplement to Flinders' Voyage, published in 1814, led the way to still more extensive generalizations on the geographical distribution of plants, and first indicated the proportions that subsist in different places between the three great divisions of the vegetable kingdom. Since that period, the progress of vegetable geography has been rapid, chiefly through the labours of Von Humboldt, Brown, Wahlenberg, Decandolle, Von Buch, Parrot, Hornemann, and Schouw; and this improvement is ascribed, by the illustrious philosopher first named, to the adoption of the natural method of Jussieu. To none of these writers are we more indebted than to Von Humboldt. The ideas developed in his *Essai sur la Géographie des Plantes*, and in his *Tableaux de la Nature*, were expanded in the *Prolegomena de Distributione Geographica Plantarum.* His invaluable *Mémoire* on isothermal lines (*Mém. d'Arcueil*, and Edin. Phil. Journ. iii. iv. and v.), and, last of all, his New Enquiries into the Laws which regulate the distribution of Vegetable Forms (same Journal, vi.), contain an admirable summary of almost all we know on vegetable geography.

The primary divisions of the natural arrangement are into *acotyledones*, which include the ferns, fungi, lichens, mosses, sea-weeds, &c.; *monocotyledones*, including palms, rushes, sedges, grasses, liliaceous plants, &c.; *dicotyledones*, which comprehend all plants not contained in the other groups. The circumstances on which the geographical distribution of these different vegetable forms depend, may all be comprehended in climate and soil. The causes chiefly modifying climate are, latitude, elevation above the sea, longitude, moisture, and insolation; particularly the first two. We shall endeavour to point out very generally how vegetation is modified by these circumstances; and, first, of the effect of latitude.

Effects of latitude on plants.

In proceeding from the equator towards either pole, the temperature diminishes; but we have seen that the isothermal lines are not parallel to the equator, and the vegetable forms which characterize them descend lower in the new than in the old continent. In equatorial regions the vegetation consists of dense evergreen forests, characterized by palms and arborescent ferns, mixed with Epidendra and rigid grasses; and the lower tribes of vegetable life, such as Fungi, Confervæ, and Musci, are very rare; but Musaceæ, Melastomaceæ, Scitaminiæ, Myrtaceæ, Piperaceæ, and the larger Compositæ, are very frequent. On receding from the equator these tropical forms give place to Rosaceæ, Coniferæ, and Amentaceæ; verdant meadows of soft grasses intersperse the landscape, the epiphytal Orchidiæ disappear, and are succeeded by plants whose fleshy roots draw their sustenance from the soil; the trunks of aged trees are clothed with mosses, parasitic Fungi invest decaying vegetables, and the waters abound with Confervæ. On entering the frigid regions trees disappear; dicotyledonous plants become more and more rare; and Gramineæ, Mosses, and Lichens are the last retreats of vegetable life. The northern hemisphere, with which we are best acquainted, is by Humboldt divided into six isothermal bands.

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[1] Edinburgh Philosophical Journal, vol. iii.

1st band has a mean temperature above 77° F., and may be considered the natural region of Palms, of the Banana, and the Coffee-tree. It extends northwards in the old continent to lat. 32°, in the new to 23° 30′.

2d band, with a mean temperature ranging between 77° and 68°, is the proper region of the Citron and its varieties. In the old continent it reaches to 37° or 38°, in the new to 29°.

3d band, with a mean temperature from 68° to 59°, is the true region of the Olive and the Vine. In the old continent it extends to 43° 30′; in the new, and in Eastern Asia, to 32° or 33°.

4th band, with a mean temperature from 59° to 50°, produces the Vine, and in perfection Wheat, and the Oak. In Europe it extends to 52° 25′, in America to 42° 25′, in China to 40°.

5th band, with a mean temperature from 50° to 41°, is the region of various Cerealia, and of forests of Quercus Robur. In Europe it extends to lat. 60°, in America probably to 50°.

6th band, with a mean temperature from 41° to 32°, is the native region of the Pine, the Birch, and the Willow, in its lowest parallels; and in its higher, of alpine plants, Lichens, and Byssi. It reaches to the limits of perpetual congelation. In Europe it extends to lat. 71°, in Asia to the arctic circle, but in Eastern America only to 57° 8′.

Effect of elevation.

But the effect of elevation above the sea is no less striking, and is capable of counterbalancing or of subverting the influence of a low latitude. Wherever lofty mountains occur in the torrid zone, their summits are veiled in perpetual snows; and the ascent presents the flora of a vast variety of climates. This is beautifully illustrated in Humboldt's *Géographie des Plantes Equinoxiales*, the chart of which forms Plate CCCCXII. in this volume. He divides Equinoxial America into eight regions.

1. The region of Palms, Scitaminiæ, and Liliaceæ. This is the habitat of true Palms, of the Musa, Theophrasta, Mussænda, Pumeria, Cæsalpinia, Hymenæa, Cecropia, and Cusparia. It extends from the level of the sea, under the equator, to the elevation of 5700 feet. One species of tree found in this region extends to the height of 6800 feet.

2. The region of arborescent Ferns, and the true Cinchona. Gigantic Ferns first appear at the height of 1200 feet, and disappear at an elevation of 4900 feet. The medicinal Cinchonæ attain the height of 8800 feet.

3. The region of Oaks commences at 5200 feet, and reaches to

4. The region of Shrubs. Trees disappear entirely at a height of 10,800 feet, and are succeeded by shrubby plants.

5. The region of plants corresponding to the alpine plants of Europe. These are first found at 6100 feet above the sea, and continue to the great height of 12,600 feet. Amongst these the most conspicuous are the genera Gentiana, Lobelia, Ranunculus, &c.

6. The region of Grasses. Here the Gramineæ are the sole vegetable produce; and the principal genera are Avena, Agrostis, Dactylis, Panicum, Stipa, Javara. In this region snow regularly falls, and the plants enumerated continue to the vast elevation of 14,200 feet.

7. The region of the Hyperoxylon, Byssi, Hepaticæ, and Lichenes. These lowly and hardy forms of vegetable life continue to the very verge of uninterrupted winter, which in the

8. Region covers the Equinoxial Andes, from the height of 15,700 feet, to their towering summits.

In the temperate climate of Europe, the changes produced by elevation, though less striking, are not less important on vegetation. M. Ramond, in examining the Pyrenees, found vegetable forms distributed into very regular zones.

1. The region of Oaks lies at the foot of the chain, and is chiefly characterized by Quercus Robur, which continues to the elevation of 4800 feet above the sea.

2. The zone of Beeches, characterized by the Fagus Sylvatica, commences at 1800 feet above the sea, and extends to 1400 feet beyond the oaks, rising to 5200 feet, or to a mile, in height.

3. The region of the Silver Fir, or Pinus Picea, and Yew. It commences at 4200 feet, and extends to the height of 6000 feet, or 600 beyond the region of Beeches.

4. The region of the Pinus Sylvestris and Pinus Pumilio, commencing at 6000 feet, and extending to an elevation of 6200 feet; and this is the extreme limit of trees.

5. Region of dry-leaved shrubs and creeping plants, such as Rhododendron, Daphne, Passerina, Globularia Repens, and two diminutive species of willow, Salix Herbacea and S. Reticulata. The limit of this last is uncertain, but it rises much beyond this region.

6. The region of alpine plants with perennial roots and naked stems; as Gentiana, Primula, Saxifraga, Ranunculus. The extreme limit of phænogamous plants is marked by Ranunculus Glacialis, Saxifraga Cespitosa, S. Oppositifolia, S. Androsacea, and S. Groenlandica. These elegant but hardy individuals, intermixed with Byssi and Lichens, reach to

7. The region of perennial snow.

As a further illustration, we may give the progress of vegetation within the arctic circle from the masterly sketch of Wahlenberg. In ascending the Lapland Alps, from the head of the Gulf of Bothnia, he found eight well-marked zones.

1. The region of the Spruce Fir had almost ceased before reaching the mountains. It had become a slender pole, with short, drooping branches. The Rubus Arcticus had ceased to ripen its fruit, and the pools were no longer ornamented with Arundo Phragmitis, Galium Boreale, and Carex Globularia. The upper limit of the Spruce Fir is 3200 feet below the line of perpetual snow. This is the true region of Tussilago Nivea; it has a mean temperature of 37°·5 of Fahrenheit.

2. Pinus Sylvestris, or Scotch Fir, is still found; but its stem is low, and its branches widely spread. In this region is the last appearance of Ledum Palustre, Salix Pentandra, and Veronica Serpyllifolia. Near the upper limit of the Scotch Fir the Phaca Alpina is found, and the berries of Vaccinium Myrtillus do not ripen well. The upper limit of this zone is 2800 feet below the line of snow; its mean temperature 36°·5 Fahrenheit. A little below this boundary barley ceases to ripen; but grazing farms, with turnips and potatoes, are cultivated, even 400 feet higher.

3. The zone of the Birch with short, thick stems and knotty branches; its lively green leaves are refreshing to the eye, but the tree is diminished, so as to be commanded from every eminence. The upper boundary of the Birch is 200 feet below the line of snow. The Alnus Incana, Prunus Padus, and Populus Tremula, had long before this disappeared; and Sorbus Aucuparia, Rubus Arcticus, and Erica Vulgaris, disappear near the upper limit of this region; but the drier spots produce Lichen Rangiferinus, Tussilago Frigida, and Pedicularis Sceptrum Carolinum, to the upper boundary of the Birch.

4. The lower skirts of this region are covered with the

dark foliage of Betula Nana; Salix Glauca fringes the streams; every hill is covered with Arbutus Alpina, and variegated with Andromeda Cærulea and Trientalis Europæa; while the bogs are ornamented with Andromeda Polifolia and Pedicularis Lapponica. This zone reaches to within 1400 feet of perpetual snow.

5. Brush-wood has disappeared; Salix Lanata is two feet high; Betula Nana creeps along the ground; the hills abound with Azalea Procumbens and A. Lapponica. No berries ripen here, except those of Empetrum Nigrum. This zone rises to within 800 feet of the line of snow; its mean temperature is 34° Fahrenheit.

6. Region where patches of snow remain all the year. Bare places still produce a few shrubby plants, as Empetrum Nigrum, Andromeda Tetragona, and A. Hypnoides, Gentiana Nivalis, G. Tenella, Draba Alpina, and Dryas Octopetala. This zone reaches to within 200 feet of perennial snow, which forms

7. Zone in which, wherever a patch of soil is visible, various Saxifrages and Ranunculi appear. The upper limit of this region is 4200 feet above the sea; but on the higher mountains we have an

8. Region of pure snow. Yet even here, if a southern aspect chance to thaw for a few days any cleft in a rock, a few hardy specimens of Ranunculus Glacialis venture to bloom. The plant has been gathered even 500 feet above the last zone; and Umbilicated Lichens have been seen 2000 feet above the line of perennial snow. The mean temperature of the eighth region is 30° Fahrenheit.

In these instances, then, the effect of elevation is equivalent to latitude; but it must be recollected, that plants will not thrive equally in places with the same mean temperature. Some require a strong ephemeral heat. Hence, in judging of the aptitude of any place for rearing particular plants, we must compare the mean temperature of the summer, as well as of the whole year, before we decide. Thus we are enabled to explain why the Pistacio-nut ripens in Pekin, but will not ripen in France, where the isothermal line for the whole year is the same; but though the Chinese winter be more severe than that of France, the summer heat is far greater. Innumerable other instances might be adduced of the same fact. The moisture of a climate has much influence upon its vegetation. Water is the vehicle of the food of plants, and perhaps yields a great proportion of it. If moisture be deficient, plants die; but they require water in very different proportions. Those with soft, broad, smooth leaves, that grow rapidly, and have many cortical pores, require much water to maintain their vitality; on the other hand, plants with few cortical pores, with oily or resinous juices, and small roots, will generally thrive best in dry situations.

Insolation, or exposure to light, is necessary for most plants. The green colour of plants is only formed in light, as is shown by etiolation; and light appears to be the cause of certain movements which are remarked in the flowers of most plants, and in other parts of some delicately organized individuals, which open and close their leaves according to the degree of light. This last property is chiefly seen in tropical plants. Light appears to be necessary to the decomposition of carbonic acid, and the fixation of carbon in their tissues; and it is indispensable to the right performance of the function of reproduction.

The influence of soil on vegetables is seen in the preference which many plants have for a calcareous soil; some affect siliceous sands, others clay retentive of water; some plants thrive best in the clefts of slaty rocks; some delight to dwell amid granitic rocks, and others on a saliferous soil. Earthy matters enter largely into the composition of some vegetables; and, in the epidermis of the Gramineæ, silica is invariably found. The presence of animal matter in soils is necessary to many plants, and is generally nutritive to all. Iron and copper are found in small quantities in some plants. The *stations* of particular plants have often been determined by these peculiarities of soil; and where a soil and climate are equally suitable for many *social plants*, we find them growing together, until the strongest obtains the mastery, and chokes the others. Thus Erica Vulgaris appears to have usurped in Europe a space once occupied by other genera, if we may judge by what generally happens on exterminating heath; for then other plants very speedily make their appearance, the seeds of which seem to have long preserved their vitality in the earth, and only to have wanted room to spring into visible existence.

A combination of these causes no doubt influences the distribution of particular species. Thus, in the old world, Ericeæ and the Proteaceæ of Southern Africa are peculiar, and are replaced in Australia by Epacrideæ and new genera of Proteaceæ. The Banksia, the Yucca, the Goodenia, and the leafless Acacia, are peculiar to the latter country. The Cinnamon, Nutmeg, and Clove are confined to the Indian islands; the Thea and Camellia are indigenous to China. America does not contain a single species of Erica, from one extremity to the other; nor has a Pæonia ever been found in it, except a solitary one observed by Douglas to the west of the Rocky Mountains. That mountain barrier divides two vegetations, almost as peculiar as those of two continents. On its eastern side the forests of North America are distinguished by the variety of their Oaks and Juglandes, the magnificent inflorescence of the Rhododendron, the Magnolia, the Azalea, and the humbler beauties of the Actea and Vaccinium; all of which are utterly unknown on the western side of that ridge. America is the real habitat of the Cinchonaceæ and the Cacti, of the Fuschia, the Calathea, the Mustisia, and all the Bromeliaceæ.

Numerical relations between different varieties of plants.

One grand question in vegetable geography, first considered by Brown, has yet to be noticed, viz. the numerical relations that subsist between different vegetable forms. We may ask, which natural families of plants abound most over the world? and give in succession the comparative numbers that are known to exist. This interesting comparison has been attempted in Decandolle's grand work. But this information is less important and satisfactory than the investigation of the relation which the numbers of each family bear to soil and climate. The question thus becomes far more complex; and we are under the necessity of comparing the ascertained number in each division with the whole mass of phænogamous plants.

It is to this last mode of studying vegetable forms that the admirable inquiries of Humboldt are directed. We strongly recommend the whole of that paper to the perusal of our readers. Our limits will only permit us to give his table of the numerical results of his investigations of the distribution of certain extensive families which exert a marked character on the vegetable physiognomy of the countries where they occur.[1]

In the following table the sign ↗ indicates that the denominator of the fraction diminishes from the equator towards the pole; ⟶ that it diminishes towards the equator; ⟵ that it diminishes from the north pole and the equator to the temperate zone; ⟶ ⟵ that it diminishes towards the equator and the north pole.

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[1] The *Agamæ* of Humboldt correspond to the *Acotyledones* of other botanists; his *Glumaceæ* include the families of *Monocotyledones* indicated in the table.

Groups founded on analogy of Form.	Proportion to the whole mass of Phænogamous Plants.			Signs indicating the direction of the Increase.
	Equatorial Zone. Lat. 0° to 10°.	Temperate Zone. Lat. 45° to 52°.	Frigid Zone. Lat. 67° to 70°.	
Agamæ (*ferns, lichens, mosses, fungi*)	Plains, $\frac{1}{15}$ Mountains, $\frac{1}{5}$	$\frac{1}{2}$	$\frac{1}{1}$	↗
Ferns alone	Countries nearly flat, $\frac{1}{20}$ Very mountainous, $\frac{1}{3}$ to $\frac{1}{8}$	$\frac{1}{70}$	$\frac{1}{25}$	←→
Monocotyledones	Old Continent, $\frac{1}{5}$ New Continent, $\frac{1}{6}$	$\frac{1}{4}$	$\frac{1}{3}$	↗
Glumaceæ (junceæ, cyperaceæ, gramineæ)	$\frac{1}{11}$	$\frac{1}{8}$	$\frac{1}{4}$	↗
Junceæ alone	$\frac{1}{400}$	$\frac{1}{90}$	$\frac{1}{25}$	↗
Cyperaceæ alone	Old Continent, $\frac{1}{22}$ New Continent, $\frac{1}{50}$	$\frac{1}{20}$	$\frac{1}{9}$	↗
Gramineæ alone	$\frac{1}{14}$	$\frac{1}{12}$	$\frac{1}{13}$	↗
Compositæ	Old Continent, $\frac{1}{18}$ New Continent, $\frac{1}{12}$	Old Cont. $\frac{1}{8}$ New Cont. $\frac{1}{6}$	$\frac{1}{13}$	→ ←
Leguminosæ	$\frac{1}{10}$	$\frac{1}{18}$	$\frac{1}{35}$	↘
Rubiaceæ	Old Continent, $\frac{1}{14}$ New Continent, $\frac{1}{25}$	$\frac{1}{60}$	$\frac{1}{80}$	↘
Euphorbiaceæ	$\frac{1}{32}$	$\frac{1}{80}$	$\frac{1}{500}$	↘
Labiatæ	$\frac{1}{40}$	America, $\frac{1}{40}$ Europe, $\frac{1}{25}$	$\frac{1}{70}$	→ ←
Malvaceæ	$\frac{1}{35}$	$\frac{1}{200}$	0	↘
Ericeæ and Rhododendra	$\frac{1}{130}$	Europe, $\frac{1}{100}$ America, $\frac{1}{36}$	$\frac{1}{36}$	↗
Amentaceæ	$\frac{1}{800}$	Europe, $\frac{1}{45}$ America, $\frac{1}{25}$	$\frac{1}{20}$	↗
Umbelliferæ	$\frac{1}{500}$	$\frac{1}{40}$	$\frac{1}{60}$	→ ←
Cruciferæ	$\frac{1}{800}$	Europe, $\frac{1}{18}$ America, $\frac{1}{60}$	$\frac{1}{24}$	→ ←

"On comparing the two continents, we find in general in the new world, under the equatorial zone, fewer Cyperaceæ and Rubiaceæ, but more Compositæ; under the temperate zone, fewer Labiatæ and Cruciferæ, and more Compositæ, Ericeæ, and Amentaceæ, than in the corresponding zones in the old world. The families that increase from the equator to the pole, according to the method of fractional indications, are Glumaceæ, Ericeæ, and Amentaceæ. The families which decrease from the pole to the equator are Leguminosæ, Rubiaceæ, Euphorbiaceæ, and Malvaceæ: the families that appear to attain their maximum in the temperate zone are Compositæ, Labiatæ, Umbelliferæ, and Cruciferæ."

Botanical regions.

Botanists have attempted to divide the globe into botanical regions. The first successful attempt of this kind was made by Decandolle, who divides it into twenty regions, the designations of which are drawn from particular portions of the earth, marked by the peculiarity of their vegetable productions. But the most able and luminous exposition of this sort is the *Phyto-Géographie* of Professor Schouw. The designations of each kingdom or region are usually derived from some of its most characteristic vegetable productions; but where we are not sufficiently acquainted with the botany of certain districts, he uses a geographical designation. Schouw divides the earth into twenty-two botanical regions, of which our limits will only allow a very imperfect sketch.

1. *Region of Saxifragæ and Musci*, or of the alpine arctic flora.—This includes all countries within the arctic circle.

2. *Region of Umbelliferæ and Cruciferæ.*—This includes the whole of Europe north of the Pyrenees not included in the last region, most of Siberia, and the Caucasus.

3. *Region of Labiatæ and Caryophylleæ*, or Mediterranean flora.—It includes the south of Europe, north of Africa, the Canaries and Azores, as well as Western Asia.

4. *Japanese Region* includes Eastern Asia and Northern China.

5. *Region of Asteriæ and Solidagines.*—The north-eastern part of the United States. It is marked by the varieties of its Oaks and Pines.

6. *Region of Magnoliæ.*—This comprehends the southern portion of the United States.

7. *Region of Cacti, Melastomaceæ, and Piperaceæ.*—This includes Lower Mexico, the West Indies, and the northern coast of South America.

8. *Region of Cinchonaceæ.*—This includes Bolivia and Columbia to a certain elevation, or Peru and New Granada.

9. *Region of Escalloniæ, Calceolariæ, Winteriæ, and Vaccinia.*—It includes the highest parts of South America.

10. *Chilian Region.*—It is formed into a district region, because not above one half of its plants occur in the lower regions of South America.

11. *Region of Arborescent Compositæ.*—This includes Buenos Ayres, and the eastern division of temperate South America.

12. *Antarctic Region.*—This includes the southern part of the American Continent, the Magellanic region of Decandolle.

13. *New Zealand Region.*—It has many plants in common with New Holland, as Epacris, Melaleuca, and Myoporum; some common to South America, as Wintera, Ancestrum, and Weinmannia; some common to South Africa, as Gnaphalium, Xeranthema, and Mesembryanthema; some which seem peculiar, as Phormium, Areca Sapida, Dracæna Indivisa.

14. *Region of Epacrides and Eucalypti.*—This embraces the southern parts of Australia and Van Diemen's Land. The families of Tremandreæ, Stackhouseæ, Protaceæ, Eucalypti, Cassuarineæ, Diosmeæ, Stylideæ, &c. characterize it.

15. *Region of Mesembryanthemum and Stapeliæ.*—This comprehends the south of Africa. Besides these plants, it is distinguished for the number and beauty of its Ericæ. It possesses several plants mentioned under 13, which are only found in it and Australia. It abounds in compositæ.

16. *Region of Western Africa.*—Its characteristic is Adansonia, the largest of known trees. Many of its Cyperaceæ are peculiar. It wants, or has very sparingly, the American Cacti, Palms, Peppers, and Passion-flowers.

17. *Region of Eastern Africa.*—Two thirds of its known

plants belong also to India. This region includes Madagascar.

18. *Region of Scitamineæ.*—This includes the flora of the Indian peninsula. It contains Carcuniæ, Zedoariæ, Cardamona, &c.; and its Scitamineæ are more numerous than the same family in America.

19. *Himalayan Region.*—Tropical forms here disappear. It bears a strong resemblance in its vegetation to some parts of Europe. Orchideæ and Filices are numerous. It presents the Cerealia and Fruits of Europe.

20. *Southern Chinese and Cochin-Chinese Region.*—The flora of this region is little known, but appears peculiar.

21. *Region of the Cassia and Mimosa.*—This includes Persia and Arabia. The peculiar plants are Senna, Balsamadendron, Cadia, Caucanthus, Stræenia, Coffæa Arabica. Ferula Assafœtida belongs to it.

22. *Polynesian Region.*—Most of the genera are common to this region and India, or to America.

SECT. X.—*Geographical Distribution of Animals.*

The slightest acquaintance with zoology is sufficient to show that animals do not indiscriminately spread themselves over every part of the habitable earth. One species is found to be peculiar to a certain region, and sometimes is represented in another region by an analogous yet different animal. Difference of climate, and the greater or less facility of procuring subsistence, are often the probable causes of such limitations, when animals have the power of emigration; but in numerous instances we can trace the operation to no secondary cause. Why, for instance, should animals, incapable of crossing arms of the sea, be found in certain insular situations, and denied to other lands, seemingly as well fitted for their propagation and their maintenance?—why should the forms of organization which we find to prevail in one portion of the globe be represented in another by other forms, and by a very different though not less admirable structure? In this species of inquiry, one thing is demonstrable, that if, in every class of animals, we compare their organization with the intended residence and mode of life of each creature, with its necessities and the nature of its aliment, the most admirable adaptation of means to the end is everywhere perceptible; whether we consider the instinct which impels the ant and the hamster to lay up stores of food for the season of scarcity, or the bee at once to solve a delicate problem in practical geometry; whether we regard the structure of the proboscis of the gnat or of the elephant as suited to their wants; or whether we contemplate the form and position of the levers that move the limbs of animals, or the exquisite mechanism of the visual organ; all proclaim the handiwork of a wise and beneficent Creator.

ogical ions.

To us it appears evident that nature has only distinguished animated beings into *species*, the limits of which are fixed by the capability of procreating fertile progeny; and that all our divisions into *genera*, *orders*, and *classes* are more or less artificial, though of high value in assisting the memory to recollect individuals, or to arrange newly-discovered species, and often as leading to interesting inferences respecting their habits and geographical distribution. When several species resemble each other in structure and habits, we agree to consider them as of one genus; when their resemblances are somewhat less numerous, we consider them as belonging to the same order; and when their similarity is confined to a few points, they are grouped in the same class. All these divisions are but artificial helps to our memory, whether we follow the system of the illustrious Swede; or, with Cuvier, found distinctions more on the anatomical structure of the animals; or, with our sagacious countryman Macleay, attempt to reduce all recognized animals to *quinary circular groups;* or, with Swainson, resolve these circles into *ternary* associations; or, with Kirby, expand these groups into the magic number *seven*. Some arrangement is absolutely necessary in pursuing the subject of animal geography, when we consider the multitude of species; and perhaps no system is so convenient as that of Cuvier, from its very general reception, and its sufficiently according with the geographical distribution of species.

Number of species.

It is not easy to give any accurate idea of the real number even of known species of animals, from the difficulties thrown in the way of animal statistics, by the multiplication of species, and from confounding the effects of sex and age on some animals, and overlooking specific differences in others. Naturalists have differed widely on this subject. The estimate of Keferstein, as exhibiting the number of extinct as well as of living species, is interesting.[1]

	Living.	Extinct.
Mammifera	883	270
Aves	4,099	20
Reptilia	1,270	104
Pisces	3,586	386
Insecta		247
Arachnida		211
Mollusca	3,816	6,056
Annelida	102	214
Radiata	187	411
Polypi	816	907
	14,759	8,826

But this table contains no account whatever of living insects and arachnides. Mr Swainson[2] gives the following as the numbers known at a later period.

Mammifera	1,000
Aves	6,000
Pisces	6,000
Insecta	120,000
Mollusca	5,100
Radiata	1,000
Polypi	1,500

In the same work Swainson has given a conjectural estimate of the number of probably existing species.

Vertebrata	17,500	Mammifera	1,200	Sp.
		Aves	6,800	...
		Reptilia and Amphibia	1,500	...
		Pisces	8,000	...
Annulosa	552,500	Insecta	550,000	...
		Vermes, &c.	2,500	...
Mollusca	7,600	Radiata, star-fish	1,000	...
		Polypi, corals	1,500	...
		Mollusca, nuda	600	...
		Testacea	4,500	..
	577,600		577,600	

Besides these, there exist innumerable hosts of *Infusoria*, in which the researches of Ehrenberg have detected remarkable peculiarities of structure; proving that, though minute, they possess a very complex organization, not less wonderful than the anatomy of the higher animals.

To these statements we may add, that M. Temminck has lately given the number of well-ascertained *mammifera* as =930, besides 140 species which he considers as doubtful; that the birds of our recent catalogues exceed 6000; and that Cuvier had enumerated 6000 species of fishes. With regard to insects, some naturalists have stated, that at least two species of insects feed on every species of plant; and therefore, that as the ascertained vegetable species amount to 86,000, there must be 172,000 species of insects.

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[1] *Die Naturgeschichte des Erdkörpers*, Francf 1834.

[2] ZOOLOGY, vol. ii. of the Cabinet Cyclopædia.

Geographical distribution of animals,

The evident tendency of animals to be congregated in groups peculiar to certain divisions of the earth's surface, had long been familiar to zoologists; but it does not appear that any attempt was made to define the limits of those zoological divisions until the appearance of the essay of Mr Swainson, in the Cabinet Cyclopædia. The ingenious author has there shown the claims of Europe to be considered as one of the grand zoological divisions of the globe, from the number of the types of natural families which it possesses. Swainson contends that the *birds* of any district afford a fairer criterion of the limits of a geographical distribution than any other class of animals. Quadrupeds he believes to be too much under the dominion of man, and liable to have their geographic limits disturbed by human interference; and the other classes of animals are either too numerous or too few to afford the means of determining the limits of such divisions; whilst birds, though seemingly fitted by nature to become wanderers, are surprisingly steady in their localities, and even in the limits of their annual migrations. These migrations are evidently caused by scarcity of food. Thus our swallows leave us when their insect food begins to fail, and they naturally pursue that route which is shortest, and affords subsistence by the way. The distance from the shores of the Baltic to Northern Africa is not half so great as that between England and America; and during the migration over land, the winged travellers find food and resting-places as they proceed to more genial climates.

The distribution of mammifera may probably be less characteristic than that of birds in Europe, where the long progress of civilization, and the spirit of commercial enterprise, have blended the races of the larger animals; so that it would be difficult, in most cases, to trace the native country of their original stock: but in most other parts of the world peculiar quadrupeds might be found sufficiently characteristic of each division.

The natural associations of animals have suggested another division of the earth into zoological *kingdoms;* and, did our limits permit, it would not be difficult to subdivide these into zoological *provinces*, each distinguished by some less considerable peculiarities of its animal productions. It is at once apparent, that these divisions will not correspond to the zones of the geographer, which do not coincide with marked differences in climate, nor with the supply of food, nor with the configuration of the dry land; circumstances most materially influencing the distribution of animals. The earth may be divided into fourteen *zoological kingdoms;* the first eight belong to the old, the six last to the new world.

OLD WORLD.

in the old world;

1. *Palæonarctic Kingdom.*—This division includes all Europe and Asia within the 60th degree of N. lat. Many of its mammifera and birds are common to it and the northern regions of America, and its peculiar animals of this class are but few. The Polar Bear it has in common with North America, but the Rein-Deer of Northern Europe now appears to be at least a variety differing from the Rein-Deer of North America; and certainly the Elk of the former should not be considered as the same species with the Moose-Deer of the latter. The Glutton, *Gulo Borealis,* seems to be confined to this region; as are the common Lemming and the Hamster. The great Sea-Otter, *Lutra Marina* of Steller, is found on both sides of the Northern Pacific, as low as 50° or perhaps 45° N. lat. The Cetacea, as might be expected, are common to the arctic seas of both worlds, and some of these occasionally wander southwards; but the true Greenland Whale, and the Narwal, are confined to the arctic seas. The birds that constantly reside in the arctic regions are very few; but this region is penetrated by numerous birds well known in other parts of Europe and Asia, which resort to it as their breeding-places during its transient summer. These birds chiefly belong to the order of *Natatores.* A single Woodpecker, *Tridactylia Hirsuta,* is peculiar to the palæonarctic kingdoms; as are the Great Wood-Grouse, and several other species of the genus *Tetrao.* The Snowy Owl and Jer-Falcon belong to this region, though occasionally they are found in the north of Scotland, and occur also in North America. Yet these regions, seemingly so inhospitable, are not without numerous tenants. No part of creation is an absolute waste, destitute of animation. It is well known that the enormous number of ducks and other water-birds which frequent the streams and lakes of arctic countries, are attracted by the infinite swarms of insect food which abound in them during their short summer. Scoresby found numerous butterflies and other insects on the bleak shores of East Greenland; and he states that the Greenland seas teem with myriads of minute animalcules, which are the food of the *Balæna Mysticetus,* and which, in sea-water examined by him, existed to the number of 110,592 in each cubic foot, or 23,887,872 in every cubic fathom of that water.

2. *Occidento-Caucasian Kingdom.*—This division is equivalent to the *European province* of Swainson; but that designation appears to be not very appropriate to a region embracing also a part of Western Asia and of Northern Africa. The zoology of this division has been more completely explored than that of any other portion of the globe, and it presents to the naturalist *types* or characteristic species of a great number of genera in all classes of zoology. It contains many imported species, some of which are domesticated, or rendered subservient to the wants of man; so that it is difficult to trace its larger mammifera to their parent stock. Its most characteristic quadruped is the *Auerocks,* or Bos Urus. It is the animal next in size to the Rhinoceros, but is not the original stock, as has been alleged, of our domestic cattle. It formerly was abundant in Europe, but has fled from human persecution into the pathless forests of Lithuania, and the wilds of the Carpathians and the Caucasus. The Brown Bear, *Ursus Arctos,* appears strictly to be a denizen of this region, though it is also found in the palæonarctic kingdom. The Ibex, the Stag, and the Roe, are also among its characteristic animals; and though the Fallow Deer is said also to be found in Eastern Asia, it appears to be chiefly an inhabitant of the Occidento-Caucasian kingdom. The Horse and Ox, though both imported, nowhere attain to greater perfection in their most valuable qualities, though the former requires the occasional transfusion of Arabian blood to preserve its energies unimpaired. Its more considerable characteristic birds are, the noble *Gypaete* or Bearded Vulture of the Alps; the Imperial and Royal Eagles of Temminck, F. *imperialis* and *chrysætos;* and several species of Falcons. The Red Grouse is found in no part of the world except the British islands. The Great and the Little Bustards are peculiar also to this division, which is particularly rich in many other genera of birds. It contains about 470 species of aves, of which 310 are inhabitants of Britain; in this list are seventeen *Raptores,* 117 *Insessores,* seventeen *Rasores,* sixty-six *Grallatores,* ninety-three *Natatores,* besides thirteen occasional visitors to our shores.

3. *Oriento-Caucasian Kingdom.*—In this division there is included all Asia between the Altaian and Himalayan chains. It should most probably be subdivided into two provinces.

a. The Mongolian province, of which the characteristic Mammalia are the *Yak, Bos Gruniens;* the Argali, *Ovis Ammon,* the Onager or Wild Ass; the Wild Horse, or *Æquus Hemionus* of Pallas. The *Felis Onea* also belongs to this region; as does the *Ursus Thibetianus,* the Thibetian Musk, which is pretty widely diffused in this division; and the lively Jerboa. Its birds are little known to the naturalist, except the few which have been brought from Dauria.

b. Septentrio-Sinican Province.—The little we know of the zoology of China enables us only to state, that this division abounds with beautiful *Phasianidæ*, particularly with the Golden and Silver Pheasants, which were originally brought from China. The *Argus Polyplectron* is said to be found in the colder regions of Thibet and China; and the *Impeyan Lophophorus*, which we have received from the Himalayan Mountains, may probably also inhabit the mountainous districts of China.

4. The *Austro-Asiatic Kingdom* may be considered as bounded by the 30th degree of N. lat. and the equator. It includes Southern China, Cambogia, Siam, the Birman empire, Hindustan, and Ceylon. It may be characterized as the native region of the Tiger, the Panther, of the Asiatic Elephant, and of the Long-armed Apes; of the Peacock, the Giant Argus, and the Hornbills; of the Gangetic Crocodile, the Python, and Cobra de Capello. Its other remarkable animals include the One-horned Rhinoceros, the Hunting Leopard, the Malayan Bear, the Ursine Sloth; that curious animal described by Sir William Jones, the Slow Lemur, or *Stenops* of Illiger; the Short-tailed Pangolin or Scaly Manis, the Brahmins' Bull, the Urneh or Wild Buffaloe, and the less-known wild ox of India, named the Gour, as well as the *Antelope Picta* or Nilghau, *A. Tragocamelus*, and several other antelopes; the beautiful Spotted Axis, and several other deer; the Pigmy and Indian Musks. Among its characteristic birds, besides those already mentioned, we should not omit the Jungle Fowl, and the Bankiva Cock, which many naturalists suppose to be the stock of our domestic poultry. The genus *Buceros* is the representative of the Toucans of America, and has the nerves of its nose distributed in its upper mandible and bony casque; the *Ciconia Argala*, or gigantic Adjutant-bird, is the most remarkable of its waders.

5. *Polynesian Kingdom.*—In this division we include the Philippines, Borneo, the Moluccas, Celebes, Java, and Sumatra. It may be considered as the native country of the great Orang-Outan, and numerous Monkeys, among which the Proboscis Monkey and Cochin-China Monkey are the most remarkable; of enormous Bats, of the Galeopithecus or Flying Lemur, of the Indian Tapir, and of a species of Musk. It is also characterized by its very magnificent birds: among these we may notice the genera *Iöra*, *Calyptomena*, *Eurylaimus*, *Irena*, *Gracula*, *Lamprotornis*, and its very splendid *Lories*. It is distinguished by the beauty and splendour of the genus *Cinnyris*, formerly included among the Creepers; and the elegance of its *Columbidæ*. It also contains the Argus Pheasant or Polyplectron, the Gigantic Argus, and the *Lophyrus Cuvierii*. Its seas abound in most beautiful and valuable shells, though it is comparatively poor in fluviatile Testacea.

6. *Chaldæo-Arabian Kingdom.*—The natural boundaries of this province are well marked by seas, the river Tigris, and by the cultivated part of Syria. It may be distinguished as the region in which the most valuable qualities of the Horse are developed, and where the Camel, and its variety the Dromedary, with the *Gazelle* or Antilope Dorcas, are the most conspicuous mammifera. Its ornithology is but little investigated; but the deserts are traversed by the Ostrich; its mountainous regions breed Pheasants and Doves; and one bird that frequents Arabia, and is greatly respected by the people, is a thrush, *Turdus Seleucus* of Forskal, which follows and destroys the innumerable swarms of locusts. The rarest and most beautiful shells are found in the adjacent seas; and the pearl-fisheries of the Persian Gulf have been long celebrated.

7. *Australian Kingdom.*—If we are permitted to include in this division New Holland, Papua, Van Diemen's Land, and New Zealand, it has one of the richest and most peculiar fauna of any on the globe. It may be characterized as the native region of the *Kangaroo*, the *Ornithorhynchus*, and *Echidna*, of the entire superb family of Birds of Paradise, of the Honey-suckers, of innumerable Parrots, of the Emeu, and *Menura Superba*. The absence of all the larger and pachydermatous quadrupeds was common to Australia, with the islands in the great Southern Ocean, at the time of their discovery, and is one reason for grouping those islands in this zoological kingdom. We have, besides the quadrupeds above mentioned, whole genera peculiar to this kingdom, particularly the *Perameles*, *Phalanger*, *Petaurista*, *Phascolomys*, and *Hypsiprymnus*. The following genera of birds are peculiar to that region: *Sericulus*, *Podargus*, *Malurus*, *Ptilonorhynchus*, *Glaucopis*, *Pardalotus*, *Mellisuga*, *Menura*, *Dacelo*, *Megapodius*, *Scythrops*, *Dromiceius*, *Ceriopsis*, &c.

8. The *African Kingdom* includes that continent south of Atlas, with the islands of Madagascar and the Seychelles. It is the region of the Camelopard, the Hippopotamus, and the Two-horned Rhinoceros, of the African Lion, the Leopard, and African Elephant, of the Zebra and Quagga, of the Pongo or Black Orang, and of the larger Baboons. It abounds in a great variety of Antelopes. These animals, with few exceptions, are found over a large extent of Africa; but the Hyrax of the Cape, and the Tenrec of Madagascar, are more limited in their range. Of the variety and beauty of its birds, some idea may be formed by consulting the splendid works of Le Vaillant. The Occipital Vulture of Burchill, and numerous Eagles, are found in its southern regions. The genera *Pogonius*, *Musophaga*, *Numida*, *Struthio*, *Anastomus*, *Touraco*, *Indicator*, *Pomerops*, *Centropus*, contain its most remarkable birds; but the brilliancy of the *Cinnyridæ* and *Lamprotornidæ* is well known. Most of the African birds brought to Europe have rich plumage. The extinct species of bird, the *Dodo*, belonged to this division of the earth, as our early voyagers found it in the Mauritius and Isle of France. The Crocodile and Cayman appear to be diffused throughout this continent. The number of poisonous Serpents is considerable, and highly dangerous in its hotter regions; yet in Africa, as in other parts of the earth, by far the greater number of snakes are harmless. Africa is peculiarly rich in land Testacea, among which is the *Achatina Zebra*, the largest of land shells. Amongst its insects, we may notice the number of its locusts, and the prevalence of the *Termes Bellicosus*, an insect allied to the ant, which constructs a mansion of clay, equalling in size, and surpassing in solidity, the simple habitations of most of the natives of Africa to the south of the desert of Sahara.

NEW WORLD.

In the new world.

The zoology of North America has been so admirably treated by Dr Richardson in his memoirs in the Sixth Report of the British Association, that it ought to be studied by all interested in such researches, who will not fail to consult the splendid *Fauna* of North America, lately published by him and Mr Swainson. In most parts of America we meet with many new genera in every class of animals, and find few species that are not peculiar to the new world, with the exception of marine animals. The *Quadrumana*, which range in America between 29° on each side of the equator, have the peculiarity of either wanting the thumb on the fore extremity, or having it so placed, or imperfectly developed, as not to be a real opponent to the fingers; while the prehensile tails of many, and the hairy buttocks of all, showing that none of them sit erect, distinguish them from the individuals most resembling them in the old world. The *Carnivora* of America are almost all peculiar to it; indeed, with the exception of some of the marine carnivora, and a very few terrestrial species, all are specifically distinct from those found in other parts of the earth. The whole order of *Marsupiata* are either American or Australian; and the species of one zoological kingdom are unknown in the other. America exceeds every other country in the number of its *Rodentia;* and there is reason to doubt whether almost any of this order are common to the two worlds. The *Edentata* occur chiefly in South America, but all are peculiar to the new world. Though America appears at one period to have been rich in the number of its *Pachydermata,* as their fossil remains testify, yet at its discovery by Europeans there were not above four or five species of this order found in that continent, all peculiar to America, and only one, *Dicotyles Torquatus,* or *Peccari,* common to its northern and southern divisions. Among *Ruminantia* we consider the American Rein-Deer and the Elk as peculiar species; and the identity of the *Ovis Montana* of the Rocky Mountains and the *Argali* of Siberia as very doubtful. The order of *Cetacea* is probably common to both worlds, with the exception of the *Manatus Americanus* of Cuvier, which occurs on the coast of Florida, and seems also to occur in that of South America. Dr Richardson reckons, that out of 207 species of Mammifera found in North America, 169 are peculiar to that country; and if we take Temminck's estimate of this class to be correct, North America contains $\frac{1}{5}$th of all known Mammalia. The same author gives the number of North American birds at 696 species, of which 54 are *Raptores*, 400 *Insessores*, 33 *Rasores*, 87 *Grallatores*, and 122 *Natatores.* Except in the last two orders, the species common to the new and old worlds are few, and a great many genera are wholly American.

The Alligator, the Boa Constrictor, and the Rattlesnake, are all peculiar to America. The former and the latter are widely diffused over the American continent; and the Rattlesnake is found even as far north as Canada.

In the new world we begin with the

9. *Neonartic Kingdom.*—This includes all America between lat. 50° N. and the pole, with Greenland and the intervening islands. The characteristic Mammifera are the Musk Ox, the Black American Bear, the Occidental Wolf, the Wolverine, and, as we have already stated, the Rein-Deer and the Moose-Deer, with several species of Marmot, Squirrel, Lemming, and other animals allied to the genus *Mus.* The animal discovered by Scoresby in Greenland, the *Mus Groenlandicus,* has since been discovered in Novaia Zembia. The Arctic Fox, Arctic Hare, and the Beaver, are common to both continents. The *Mustela Erminea* and *Ursus Maritimus* seem identical in both.

The Raptorial birds peculiar to this region are, several kinds of hawks and owls; of the genus *Tetrao, T. Canadensis, T. Franklinii, T. Obscurus,* and *T. Leucurus.* Most of the *Natatores* are also found in the first zoological kingdom. The *Cycnus Buccinator* is peculiar to this region; and among the duck tribe we may notice as American species *Anas Valisneria, A. Canadensis,* and *A. Hutchinsónii.*

10. *Septentro-American Kingdom.*—In this region, on account of the considerable similarity of species, we would include all the British possessions south of lat. 50°, New Albion, and the other country west of the Rocky Mountains, between Queen Charlotte's Sound and New Mexico, and all the territories of the United States, as far as lat. 30° N. It may zoologically be characterized as the region of the Griesly Bear, the Bison, the Wapeti, the giant of the deer tribe, and of the *Antelope Furcifer.* It possesses one marsupial animal, *Didelphis Virginica,* a species which ranges from the lakes of Canada to the intertropical regions of America. But its most distinguishing characteristic is the number of its *Rodentia,* amounting to not less than fifty-three well-ascertained species, and only one of which, the Beaver, is found in the old continent.

Its birds are numerous, and among these the Wild Turkey is the most conspicuous and characteristic. Of the *Raptores* it has many falcons and hawks, and, among the rest, Washington's Eagle, a magnificent bird, which is found in Kentucky. Of its numerous *Insessores,* the greatest number are peculiar to North America. The *Trochilidæ* first appear in this region. A considerable number of species are found in it, but only three range to the north of latitude 33°. They resemble in structure the *Honey-eaters* of the Australian kingdom; but we doubt the propriety of denominating the Humming-Birds *suctorial;* for, having dissected a considerable number of them, we invariably found their stomachs crammed with minute insects. To capture these is probably the object of their fluttering about flowers, the nectar of which they were supposed to sip. Their structure, too, assimilates them to insectivorous birds. The *Rasores* of this kingdom are all, except a single species of *Tetrao,* peculiar to America. Of this genus the most remarkable are *Tetrao Cupido, T. Umbellus, T. Franklinii, T. Urophasianus, Oxtyx Douglasii, O. Picta.* Of the numerous *Grallatores* found in this region a considerable number occur also in Europe, and still more of the *Natatores;* but of the former order, the *Ardea Herodias, Platalea Aiaia, Ciconia Maguari,* are peculiar to America; as are of the latter order *Pelicanus Americanus,* and *Rynchops Nigra.* The *Alligator Lucius* abounds in the valley of the Mississippi. Two very peculiar reptiles are there found, the *Syren Lacertina* of Carolina, and *Meopoma Gigantea.* These have no animal at all resembling them in the old world, except the *Proteus Anguinus* of the subterranean lakes of Carniola. Among the numerous tortoises there may here be noticed *T. Serpentina, T. Ferox,* and *T. Clausa.* The serpents are numerous; the most remarkable are the Rattlesnakes, four, if not five, distinct species of which are to be found in this kingdom.

11. *Equinoxial American Kingdom.*—Using this term in an extended sense, we would include under it the regions between the parallels of 30° N. and S. of the equator, but exclusive of the elevated valleys and table-lands of Mexico and Bolivia, which, from the peculiarities of their climates, are entitled to be considered as separate zoological kingdoms.

The division under consideration is distinguished by the number of its *Quadrumana,* all of which are furnished with tails, and many of them have that organ *prehensile,* or so formed as to constitute a sort of fifth hand. It is the region of the Jaguar, a beast of prey of vast strength and courage, so very unlike the account of its habits in the pages of Buffon, that it is now generally supposed that the French naturalist confounded it with another South American *Felis,* the Ocelot.[1] In this region, too, the Puma abounds, an animal that has far less claim to the name of *lion of America* than the Jaguar has to be termed the *tiger* of that continent. The Puma has a considerably larger range than its congeners now mentioned, being found in the woods of America from Brazil to Canada. We once possessed the large skin of a black Jaguar, killed in Brazil, which is now deposited in the museum of the Royal Institution in Liverpool. It is of a beautiful deep blackish-brown ground, on which, in certain lights, the still deeper ocellated marks of the Jaguar are visible. It also abounds with the Tapir, the Capybara, and the Agouti. The Orinoco and other rivers of Equinoxial America swarm with the Manati, *Trichechus Amazonius,* which wanders far from the sea, as does a species of Porpesse not yet ascertained. It is also distinguished by the splendour of the plumage of its birds, of which numerous genera are either wholly peculiar to Tropical America, or are almost unrepresented in other regions. Its Raptorial birds are often distinguished by their size. To this region belong the magnificent King Vulture, and a very numerous species of the same family as large as a turkey, the *Vultur Uruba;* the Destructor and Harpy Eagles, the giants of their tribe, are the tyrants of the lower provinces. The *Insessores* of Tropical America are very numerous. Among them the American genera *Trogon, Galbula, Ampelis, Rupicola, Procnias, Nectarinia,* and *Trochilus,* are remarkable for the magnificence of their plumage. The bell-bird, *Casmarhynchus Carunculatus,* is celebrated for the deep intonation of its simple note, which simulates the distant bell of a convent; the Troupiales are distinguished by the abrupt yet pleasing contrast of their colours. The enormous Goatsuckers, especially that of the cave of Caripe, and the *Momots* or *Prionites,* are peculiar to this region. The Toucans and Aracaris are conspicuous for the size and structure of their bills, in which the organs of smell are conspicuously developed. Tropical America also abounds with beautiful Psittacidæ, among which the Ultramarine Parrot, the Scarlet and Blue, and the Blue and Yellow Macaws, are the most conspicuous.

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[1] See Humboldt's Personal Narrative.

The beautiful family of *Crax* or *Pauxi,* of *Penelope,* the singular *Rhea,* and *Serpent-eater,* are among its *Gallinaceæ;* the Boat-Bill, *Cancroma,* and the remarkable species *Mycteria Americana,* and *Palamedea Cornuta,* the Scarlet Ibis, the Trumpeter or *Psophia Crepitans,* the Jacana, are among its waders.

This region abounds with snakes. Some, like the *Boa Constrictor* and *Boa Cenchris,* are remarkable for their enormous size; others, like the Canine Boa, Garden Boa, the Peruvian and Mourning Snakes, for the beauty or elegant pattern of their colours; others, like the Rattlesnake, *Crotalus Durissus,* or the redoubted Bushmaster, *Fer de Lance* or *Vipera Megæra,* dreaded for the virulence of their poison. The fluviatile fishes of this region are remarkable; but we can only here notice the Electric Gymnote, the Soldier Loricaria, and the *Salmo Rhombeus;* the latter the pest of the South American rivers. The *Papilionidæ* and *Phalænidæ* among its insects, are noted for the splendour of their colours and their size; and the singular Lantern-fly for the brilliancy of its phosphorescence. The wounds inflicted by the large *Aranea Avicularia,* or Bird-catching Spider, the *Scolopendra Morsitans,* which there grow to an enormous size, and by a small species of scorpion, are much dreaded. In these Arachnidæ, dissection shows a tubular offensive weapon, and a poison apparatus resembling that connected with the poison-fangs of serpents.

12. *Mexican Kingdom.*—Its animal productions, though but imperfectly explored, would seem to justify the inference drawn from its peculiarities of climate, that this portion of America should be considered as a distinct zoological kingdom. It has been recognised as the point in which the faunæ of North and South America meet. There the Wolf of a northern climate ranges the same forest as the Monkey of a tropical region; the Bunting and the Titmouse nestle near the Parrot and the Trogon; the Phalarope of the north searches for its food on the same beach with the Jacana and the Boat-bill of Brazil.[1] Lichtenstein has indicated several species of Weasels and Martens as peculiar to Mexico. The *Bassaris Astuta* of Lichtenstein is an intermediate genus between *Viverra* and *Nasua.* The Mexican Wolf is perhaps a peculiar species. Mr Swainson states, that out of 114 species of Mexican birds examined by him, sixty-seven, or more than one half, are peculiar to that country; yet, among so many species, there was but a single new genus, *Ptiliogonys,* which unites the Tyrant Shrikes with the Caterpillar-eaters; thirty-six species are common to Mexico and the United States, and eleven to Mexico and South America. The lakes of the valley of Mexico contain that singular animal the *Axocotl* of the Mexicans, the *Siren Pisciformis* of Shaw, which seems to be intermediate in appearance between the other Sirens and the Protæi.

13. *Bolivio-Chilian Kingdom.*—The vast elevation of the greatest part of this region has strongly impressed its fauna with peculiarities which future research will extend. In the mean time, it is sufficiently characterized as the region of the *Guanaco,* the *Alpaca,* and *Vicuña,* three distinct species, which have sometimes been confounded under the name of Llama. They are the Camels of South America, and were almost the only mammalia subdued and domesticated by the ancient Peruvians. This is the peculiar region of the *Condor,* a bird which, though not so enormous in size as the earlier travellers reported, is still as large as the Læmergeyer of the Alps, the largest of the Raptores of the old world. It loves to dwell amid the snowy solitudes of the Andes, perched on pinnacles from 9700 to 1500 feet above the sea, whence it pounces on its prey in the subjacent valleys. The fauna of these countries is still imperfectly explored.

14. *Austro-American Kingdom.*—This district extends from lat. 30. S. to Cape Horn, and embraces the *Pampas* of Buenos Ayres and the south of Chili. Its fauna has been little explored. Amongst its quadrupeds are the numerous heads of wild horses and sheep, originally introduced by the Spaniards, but now spread over a great part of South America. The *Antarctic* and *Chili Fox* seem to be peculiar; and perhaps the *Felis Colorolo* and *F. Guigna* of Molina should be considered as belonging to it. On its coasts many species of seals are found, especially the *Phoca Longicollis* or *Fur-seal, Ph. Falklandica, Ph. Flavescens, Ph. Leonina* or *Bottle-nosed Seal, Ph. Lupina,* and *Ph. Jubata,* which is also found, it is said, in the seas of Kamtschatka. The extensive *Pampas* of this region are the chosen haunts of the *Rhea,* or *American Ostrich;* and on its southern coasts are found the huge, wingless, Patagonian Penguin, with the whole genus *Pachyptila,* judiciously separated by Illiger from the Petrels.

Such is an imperfect sketch of the distribution of animals over the globe. But the natural limitation of species has been in some measure affected by human agency. The domesticated animals have been by man imported from different parts of Asia into Europe, and finally into America. At the discovery of that continent it was without the horse, the cow, the sheep, the hog, the dog, and our common poultry, all which are spread over it in innumerable herds, and in some places have relapsed into the wild state in countries well suited for their subsistence. The same useful animals have been by Europeans, within the last half century, carried to the larger islands of the Pacific, where they were previously unknown. How many insects may have been propagated by the cargoes of our ships in distant lands, it is easier to conjecture than to estimate; how many have been imported with the cerealia, and other gramineæ of Europe, into newly-discovered regions, it is impossible to say. Human agency has sometimes been the means of propagating in Europe disgusting or destructive species from foreign regions. Thus the commerce of the Dutch wafted the *Teredo Navalis* to the dyke-defended coasts of Holland, to the imminent hazard of that country; the Brown Rat and the *Blatta,* which now infest this country, are believed to be importations from the East Indies; and the white bug that now lays waste our orchards is stated to have reached us with American fruit-trees.

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[1] Richardson, Report of the British Association, vol. v.; and Address, vol. vi.

Still the effect of human agency is confined, and the limitations imposed by nature upon animal migrations are generally preserved.

SECT. XI.—*Varieties of the Human Species.*

The identity of *species* in the whole human family is indicated in the sacred Scriptures, and is confirmed by the deductions of the physiologist and the anatomist. The true principle which serves to mark identity of species in the animal kingdom, is the propagation, not of *hybrids*, but of fertile progeny between a male and female of a different race. The offspring between individuals of all the known races of mankind are equally fertile with the progeny of a pair of the same nation; and, therefore, it can be no longer doubted that man is everywhere of the same *species*. There are, however, several well-marked *varieties* of the human species, that appear distributed in a peculiar manner over the earth; and hence the *Geographical Distribution of Man* becomes an object of our attention.

Man appears to possess a remarkable pliancy of constitution, and to be the only animal fitted by nature to inhabit every possible variety of climate. His animal existence is not less secured in the frozen regions of the arctic circle, or under the burning climate of the equator, than in the intermediate countries; and he may be said to be the only true denizen of the whole world.

Varieties of the human species.

The classification of Cuvier, in his *Tableau Elémentaire*, divided the human race into five varieties, viz. 1. the White Race; 2. the Lapland, Samoied, and Esquimaux Race; 3. the Mongolian Race; 4. the Negro Race; 5. the American Race. In his *Regne Animal* he seems inclined to confine them to three, of which the characteristics are very strongly marked, the *White*, the *Yellow*, and the *Black* Races; but he admits that the *Malays* and the *Americans* are not easily distinguishable from any of the three great varieties of mankind in the ancient continent. Blumenbach considers the varieties as five, viz. the *Caucasian*, the *Mongolian*, the *Ethiopian*, the *Malayan*, and the *American*; and this distribution, though not altogether free from objection, seems one of the best hitherto proposed.

1. *Caucasian Variety*, is so named, because the traditions respecting the diffusion of the human race seem to point out the region between the Caspian and Black Sea as the cradle of this race, from which there have been numerous radiations; and the most perfect specimens, in point of beauty of form, are found among the Georgians and Circassians, still inhabiting the native seats of their race. The characteristics of the Caucasian Variety are, the fair skin, the oval contour of the head; soft hair, varying from black to light brown or flaxen, waving or slightly curled; eyes varying from blue to dark brown; cranium expanded; facial angle large; nose thin, and rather aquiline or straight; small mouth, perpendicular cutting teeth; lips gently recurved; chin full and rounded. In this race the intellectual qualities have been more strikingly displayed than in any other. Its principal branches may be still traced by certain, though often not very obvious, affinities in the structure of language. The most ancient offsets appear to have been that to the south and the east. The Southern Armenian or Syrian branch seems to have been the parent stock of the Assyrians, the Chaldeans, the Arabs, the Jews, the Phœnicians, and Abyssinians. The examination of the most ancient mummies would lead to the conclusion that the ancient Egyptians belonged to the same stock, though the Ethiopian countenances of some of their sculptures have sometimes led to a different conclusion. We believe, however, that these may be transcripts of venerated originals imported with the religion of Egypt from the Nubian Meröe.

The second branch appears to have given rise to the ancient Medes, the Persians, the Afghans, and the higher castes of India whose language was the Sanscrit; whilst another portion of it, taking a westerly direction, spread itself over Asia Minor, and, under the name of Pelasgians, penetrated into Europe. It seems to have been preceded by an offset from the same branch, the Celts, who early penetrated to the western shores of Europe, where they were found, after the lapse of centuries, by the Teutones, a younger shoot from the same stock. The whole nations already mentioned, and the whole present inhabitants of Europe, with the exception of the Samoieds and Laps, are derived from the Caucasian Variety, the most scattered and most energetic of the human family; and the affinity in descent will account for the strong resemblances which have been traced between the languages of India, of ancient Media, and the principal European tongues. The Scythian branch of the Caucasian race may be considered as the ancestors of the Parthians, the Tatarians of the Taurida, the Turcomans, the Finlanders, the Hungarians, and the tribes about the mouths of the Danube and to the north-east of the Euxine.

2. *The Mongolian Variety* seems to have had its original seat in the vicinity of the Altaian chain of mountains. It is characterized by an olive complexion, and black eyes, the outer angles of which are pointed rather upward; their hair coarse, lank, and thin, their beard scanty; the head of a square form, with a low and narrow forehead, a broad and flattened face, high cheek-bones, flat nose, a wide mouth, and thick lips. Two branches of this race are represented by the Nomade *Kalmucks* and *Kalkas*, whose ancestors spread devastation over a large portion of the earth, under their leaders Attila, Zenghiz Khan, and Timûr. A third branch, the *Mantscheou*, in later times had conquered China, of which they are still the rulers. The ancient Chinese, however, seem to have belonged to the same race; and the Japanese, the Coreans, and people of Thibet, probably are also offsets from the great Mongolian variety. The Esquimaux of America appear from their form to belong also to the Mongolian Variety; and may have passed into America on the arctic ices, just as rein-deer now do annually; or as the Tschutskoi have been frequently known to do in order to attack the American Indians. The Laps, the Samoieds, the Tschutskoi, and the Kamtschatkadales, bear strong marks of their Mongolian origin, though some are disposed to regard them as derived from the Scythian branch of the Caucasian race.

3. The *Ethiopian Variety* owns Africa as its native region. This variety is distinguished by a black or very dark skin; black eyes; woolly, crisp, coarse hair, collected into little knots; a skull laterally compressed; a forehead low and narrow, a small facial angle, produced by the inordinate projection of the maxillary bones, with an oblique position of the front teeth, and a small chin; the nose flat and simous; the lips, especially the upper, thick; the arms long; the legs often slightly bowed. Lawrence has satisfactorily shown that there is not one peculiarity of the negro race, which is not occasionally met with in some of the other races; and that there is no reason to believe that the negro is not of the same origin as the rest of mankind. Mr Browne, and other recent travellers, have stated, that the Furians and Nubians, though black, have often handsome elevated features; and we have seen a jetty negress, from the eastern shores of Africa, with features that might well have been a model for a Grecian statue of Juno in bronze. Those variations are probably from the intermixture of the Caucasian with the Negro race.

In the Malayan peninsula, in Luçonia, and in Borneo, among the mountainous districts, are found a few scattered tribes of black men, who form the chief population of Papua or New Guinea. They have dark skins and woolly hair, and, if we may judge from the native of Papua brought to England by Sir Stamford Raffles, the *Papous* do not materially differ from the natives of the eastern coast of Africa, whence probably their ancestors have emigrated.

4. *The Malayan Variety* has its native seats in the Malayan peninsula and the adjacent islands. The inhabitants of Polynesia, New Holland, and New Zealand, are believed to belong to this race. It is far less characterized than the three races before noticed, and perhaps might be considered as produced by their intermixture. The perspicuous characteristics are a brown colour; sometimes almost approaching to white, as in the inhabitants of Taheite and the Marquesas, at other times very swarthy, as in the New Zealander and Australian. The hair is black, thick, and generally slightly curled; the head is laterally compressed, the forehead rather narrow, but high; the bones of the face large; the nose full, broad at the apex, and passing gradually into the cheeks; the mouth large; the lips rather thick; the eyes sometimes have the Mongolian cut; the hands are small. But many of the islands are occupied by a very handsome race of inhabitants. The Malay language is widely scattered over the islands of the Pacific, which shows a common origin. The recent South Sea voyages show the vast distances to which design or accident has carried the people of one group of islands to another in their frail canoes, and point out how those islands may have been originally peopled.

5. *The American Variety* was spread over all that continent at its discovery in the end of the fifteenth century. This race, like the last, is not very distinctly characterized, but bears a very strong resemblance to some of the Mongolian tribes in the scantiness of the beard, which is general in both parts of that continent. The principal peculiarities of this race, besides the scanty beard, which they generally try entirely to eradicate, are a dark skin, with a tint of red, or what has, not very happily, been termed a *copper-colour*. The hair is black, lank, long, and coarse. The skull is very similar to the Mongolian, but the features are more prominent, especially the nose; the forehead is generally low and retreating; the eyes deeply set; and the face, across the cheek-bones, broad, the mouth large, the lips rather thick. Some of the native tribes singularly flatten the head by compression while in the infant state. This is particularly the case with a tribe on the Columbia. One of their skulls, in the College Museum of Edinburgh, is depressed in a most extraordinary degree, so that the frontal sinus seems almost as high as the vertex; and the head is posteriorly and laterally extended. This was the skull of a person of rank. It was procured by the late Dr Gairdner, along with the skull of a slave of the same tribe, in which this flattening, no doubt esteemed a great beauty, had not been practised, but which exhibited, to our eyes, a much more handsome form than that of his master.

The peopling of America was long a problem of much difficulty; but it has of late years been elucidated in various respects. Strong affinities have been discovered between the languages of America and Eastern Asia, which confirm the inferences drawn from physiognomy. Sidi Melli-melli, Tunisian envoy to the United States in 1804, on seeing the deputies of the Cherokees, the Mianis, and Osages, assembled at Washington, instantly recognised their Tatar physiognomies; and Genet, when minister plenipotentiary of France, was also struck with the resemblance of the Indians of America to the Asiatic Tatars, with whose appearance he was familiar. The late researches of Dr Heckewelder, and other American archaiologists, have reduced the supposed infinite variety of North American tongues to three or four radical languages. According to this authority, all the North American native tongues may be traced to the Floridan, the Lené-Lenapé, the Iroquois, and the Chepewyan; and the researches of Klaproth, and other German philologists, have strengthened the belief in the affinities between the native American languages and those of Eastern Asia.

The traditions of the Mexicans, and their hieroglyphical writings, trace their migrations from the north to the table-land of New Spain. Their mythology and their calendars strongly indicate an Asiatic origin,[1] whilst their architecture and their pyramidal temples have something of an Indian or Egyptian character. The scanty annals of this singular people show, that migrations from the north-west had at different epochs reached the elevated table-land of Mexico.

The first occupiers, or aborigines, are named the *Olmecks*. How long they had been there does not appear; but they were driven out in the year 648 of our era by the *Toltecks*, a people who left their country, which they named *Tlapallan*, supposed to be in Eastern Asia, in the year 544. A pestilence seems to have weakened this nation in 1051; and in 1170 the *Chichimacks* migrated into Mexico, where, eight years afterwards, the *Anahuatlacks* also arrived. This last nation consisted of seven tribes, the principal of which were the *Aztecks*. This tribe called their native country *Aztlan*, which they left in 1064, according to Gama; and, uniting themselves with the Chichimacks and the remnant of the Toltecks, they founded the city of *Tenochtitlan* in 1325. It was this united people whom the Spaniards denominated *Mexicans*, and whose empire was extinguished at the capture of the capital, Tenochtitlan, by Cortez in 1521.

The Toltecks appear to have pushed colonies into South America, either by the Cordillera of the Andes, or by the eastern plains at their feet. When Gonzales Ximenez de Quesada arrived on the table-land of Bogota, he was surprised to find a population on that plateau in a state of considerable civilization. It consisted of four tribes, all clothed in cotton garments, and settled in agricultural communities. The principal tribe was the *Muysca*, who possessed a calendar, the intercalations of which had as striking a similarity to that employed by nations on the banks of the Indus, as that of the Mexicans approached the calendar of the Mantcheous;[2] and it is believed that the Muyscas deduced their calendar from the motions of Jupiter in the ecliptic.

Several travellers have been struck with the resemblance of the Peruvian to the Malayan race; and it is possible that, by the isles of the Pacific, their ancestors reached the southern Cordillera. Their architecture has a sort of Egyptian character in the form of its apertures, and the squaring of its blocks of stone; but their theocracy had much resemblance to that of some nations of Central Asia.

Our limits preclude our pursuing this interesting subject further, or entering on the consideration of the alleged causes of the varieties of the human species. We must refer our readers to the *Researches* of Humboldt, to the *Physiology* of Lawrence, to *L'Histoire Naturelle du Genre Humain* of Virey, to the *Dissertations* of Blumenbach, Cuvier, and Klaproth, to the work of Dr Smith of New Jersey, to Prichard's *History of Man*, and to the article MAN in the present work. Suffice it to state, that whilst some attribute the varieties of the human family to the long-continued action of climate, food, and the external condition or habits of life, others have regarded them as the consequences of accidental peculiarities transmitted to the posterity of the individuals affected by them; and a third class have considered the three great varieties of the human race as directly derived from the individual qualities of the sons of Noah. But whatever view we take, it will not be found the less difficult to account for the marked national peculiarities of people confessedly derived originally from the same stock.

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[1] Humboldt, *Recherches*.

[2] *Ibid*.

In conclusion, we may remark, that the study of physical geography, both as it regards inorganic and animated nature, tends to exercise the intellect in tracing the connection between natural causes and their consequences, and to expand and elevate the mind to the noblest of human contemplations,—the wisdom and beneficence of the Deity.

> "I cannot go
> Where universal Love not smiles around,
> Sustaining all yon orbs, and all their sons;
> From seeming evil still educing good,
> And better thence again a better still,
> In infinite progression."

(I. I. I.)

EXPLANATIONS OF REFERENCES TO TABLES OF MOUNTAINS.

PLATE CCCCXII.

America.

		Feet.	
1	Nevada de Sorata	25,250	Andes of Peru and Bolivia.
2	Nevada d'Illimani, first peak	24,450	....
3	Ditto, second peak	24,200	....
4	Chimborazo	21,440	....
5	Antisana	19,150	....
6	Cotopaxi	18,890	....
7	Arequipa, volcano	18,373	....
8	Descabeçada	18,000	....
9	Popocateptl	17,716	Mexican chain.
10	Iliniza	17,376	Andes, Bolivia.
11	Citlalpetl, or Peak of Orizaba	17,371	Mexican chain.
12	Tunguragua	16,579	Andes, Bolivia.
13	Nevado de Merida	16,420	Colombia.
14	Cerro de Potosi	16,000	Andes, Bolivia.
15	Pichincha	15,940	....
16	Nevado de Mexico	15,700	Mexican chain.
17	Coffre de Perote	13,514	....
18	Bighorn, or Long's Peak	13,430	Rocky Mountains.
19	Mount St Elias	12,670	....
20	James's Peak	11,500	....
21	Sierra de Cobré	9,000	Cuba.
22	Serrania Grande	9,000	Haiti.
23	Mount Fairweather	8,970	....
24	Duida, volcano	8,467	Colombia.
25	Blue Mountains	7,486	Jamaica.
26	Mount Washington	6,659	White Mountains, U. S.
27	Guadarrama	6,400	Colombia.
28	White Mountains	6,234	New Hampshire.
29	Blaaserk	6,000	East Greenland.
30	Werner Mountains	6,000	....
31	Morne Garou	5,110	St Vincent, W. I.
32	Souffrière	5,041	Guadaloupe, ditto.
33	Moose Hillock	4,636	New Hampshire, U. S.
34	Jorullo, volcano	4,267	Mexico.
35	Pelée	4,260	Martinique, W. I.
36	Camel's Rump	4,188	United States.
37	Saddle Mountain	4,000	....
38	Kaatskill	3,454	New York.
39	Killington Peak	3,450	Vermont.
40	Grand Monadnock	3,254	New Hampshire.
41	Appalachian Peak	2,700	United States.
42	Cape Horn	1,870	Tierra del Fuego.

Asia and Oceanica.

		Feet.	
1	Dhawalagiri	26,862	Himalaya.
2	Jewahir	25,749	....
3	Jamautri	25,500	....
4	Dhaibun	24,740	....
5	Hindoo Kho	20,800	....
6	Mowna Kaah	18,400	Owhyhee, or Hawaiah.
7	Elburz	17,796	Caucasus.
8	Agri-dagh, or Ararat	17,266	Armenia.
9	Klioutsherskoi, volc	16,512	Kamtschatka.
10	Mowna-Roa	16,020	Owhyhee, or Hawaiah.
11	Kazbec	15,345	Caucasus.
12	Demavend	15,000	Irak.
13	Ophir	13,842	Sumatra.
14	Arjish-dagh, Argæus	13,100	Asia Minor.
15	Gunong Dempu, volc.	12,465	Sumatra.
16	Egmont	11,433	New Zealand.
17	Koriatskaia, volcano	11,215	Kamtschatka.
18	Bielukha	11,000	Altai.
19	Peak	10,895	Otaheite.
20	Italitskoi	10,735	Altai.
21	Krionotskaia, volcano	10,625	Kamtschatka.
22	Shivelutsh, volcano	10,591	....
23	Parmesan	10,050	Banca.
24	Lebanon	9,520	Syria.
25	Awatska, volcano	8,760	Kamtschatka.
26	Dodabetta	8,760	Neilgherries.
27	Daneshken Kamen	8,500?	Ourals.
28	Pedro-galla	8,280	Ceylon.
29	Me-lin	8,200	Quantong, China.
30	Kirrigal Pota	7,810	....
31	Tottapella	7,720	....
32	Peak of Jesso	7,680	Island of Jesso.
33	Sinai	7,500	Arabia Petræa.
34	Adam's Peak	7,420	Ceylon.
35	Olympus	6,500	Asia Minor.
36	Bettigo	6,500	Western Ghauts.
37	Sea-view Hill	6,500	New South Wales.
38	Quelpaert	6,400	Quelpaert Island.
39	Subramani	5,560	Western Ghauts, India.
40	Jebal Akral, or Cassius	5,318	Syria.
41	Aboo	5,100	Aravulli, India.
42	Ida	4,960	Asia Minor.
43	Corean Mountains	4,480	Corea.
44	Baskirian Ourals	4,400	Siberia.
45	Benlomond	4,200	Van Diemen's Land.
46	Plain of Ispahan	4,140	Irak, Persia.
47	Mount Wellington	3,795	Van Diemen's Land.
48	Forest Hill	3,776	New South Wales.
49	Mount York	3,292	....
50	Mount Exmouth	3,000	....
51	King's Table-land	2,827	....
52	Sugar Loaf	2,527	....
53	Chaisgour	2,400	Vindhya Mountains, Ind.
54	Mount St Paul's	2,400	Van Diemen's Land.
55	Carmel	2,160	Syria.
56	Tabor	1,950	....

Africa.

		Feet.	
1	Mountains of Geesh	15,000	Gojam, Abyssinia.
2	Mountains of Amid	13,000	....
3	Cameroons	13,000	Biafra.
4	Peak	12,236	Teneriffe.
5	Lamalmon	11,400	Samen Mountains, Abyssinia.
6	Miltsin	11,200	Marocco.
7	Clarence Peak	10,655	Fernando Po.
8	Nieuveldt	10,000	Beaufort, Cape of Good Hope.
9	Compassberg	10,000	Graffreynet, ditto.
10	Volcano	7,884	Fogo.

		Feet.	
11	Taranta	7,800	Tigré, Abyssinia.
12	Volcano	7,680	Isle de Bourbon.
13	Trigo	7,400	Canaries
14	Peak.	6,900	Pico, Azores.
15	Peak.	6,400	Tristan da Cunha.
16	Khamies	5,300	Cape of Good Hope.
17	Ruivo	5,162	Madeira.
18	Komberg	5,000	Beaufort, Cape G. Hope.
19	Table Mountain	3,582	Cape of Good Hope.
20	Devil's Peak	3,315	....
21	Green Mountain	2,868	Ascension Island.
22	Diana's Peak	2,692	St Helena.
23	Lion's Head	2,166	Cape of Good Hope.
24	Cape of Good Hope	1,000	....
25	Pyramid of Cheops	720	Egypt.

Europe.

		Feet.	
1	Mont Blanc	15,781	Alps.
2	Mont Rosa	15,585	....
3	Ortler Spitze	15,430	....
4	L'Alle Blanche	14,775	....
5	Louçeira	14,451	....
6	Loupilon	14,144	....
7	Finster-aar-horn	14,116	....
8	Furca	14,040	....
9	Olan	13,838	....
10	Jungfrau-horn	13,720	....
11	Glockner	13,713	....
12	Schreck-horn	13,397	....
13	Orteles	12,859	....
14	Breit-horn	12,800	....
15	Nager-horn	12,217	....
16	Hohen-wartshohe	11,676	....
17	Mulahacen	11,673	Sierra Nevada, Spain.
18	Mont Cenis	11,460	Alps.
19	Pico de Veleta	11,398	Sierra Nevada, Spain.
20	Mont Perdu	11,283	Pyrenees.
21	Great St Bernard	11,006	Alps.
22	Simplon	11,000	....
23	Monte Gibello (Ætna)	10,963	Sicily.
24	Maladetta	10,857	Pyrenees.
25	Aiguille Noire	10,505	Alps.
26	Pic Blanc	10,205	Pyrenees.
27	Buet	10,112	Alps.
28	Gros Kogl	9,700	....
29	Little St Bernard	9,594	....
30	Canigou	9,290	Pyrenees.
31	Lomnitz	8,540	Carpathians.
32	Orbelus	8,500	Greece.
33	Guadarrama	8,500	Sierra de Guadarrama.
34	Velino	8,397	Naples.
35	Pic d'Arbizon	8,344	Pyrenees.
36	Parnassus	8,000	....
37	Taygetus	7,200	Morea.
38	Pindus	7,000	Albania.
39	Mont d'Or	6,707	Puy de Dome.
40	Agion Oros (Athos)	6,700	Greece.
41	Olympus	6,500	....
42	Brenner	6,463	Tyrolese Alps.
43	Puy de Cantal	6,355	France.
44	Puy de Sausi	6,300	....
45	Oraefa Yökul	6,240	Iceland.
46	Areskutan	6,180	Jemptland, Sweden.
47	Rigi	6,050	Schweiz.
48	Malhao	6,000	Estremadura.
49	Sulitelma	5,910	Norway.
50	Dole	5,412	Mont Jura.
51	St Angelo	5,260	Lipari Islands.
52	Rossberg	5,154	Alps.
53	Gross Rader	4,972	Silesia.
54	Schneekopf	4,950	Riesengebirge, Silesia.
55	Dovrefeldt	4,875	Dovrefeldt, Norway.
56	Puy de Dome	4,750	Puy de Dome.
57	Ochsenkopf	3,980	Fichtelgebirge, Bohemia.
58	Vesuvio	3,978	Naples.
59	Erzgebirge	3,781	Bohemia.
60	Brocken	3,690	Hartzwald.
61	Montserrat	3,300	Catalonia.
62	St Oresté	2,271	States of the Church.
63	Gibraltar	1,439	Andalusia.
64	Valdai Hills	1,200	Novgorod, Russia.
65	Montmartre	400	Department of La Sene.

British Islands.

		Feet.	
1	Greenwich Observatory	214	Kent.
2	Holyhead	709	Anglesea.
3	Carraton	1,208	Cornwall.
4	Penmaen Maur	1,540	Caernarvon.
5	Axedge	1,751	Derby.
6	Pendlehill	1,803	Lancashire.
7	Brown Clee	1,805	Shropshire.
8	Holmemoss	1,859	Derby.
9	High Pike	2,101	Cumberland.
10	Camfell	2,245	Yorkshire.
11	Whernside	2,334	....
12	Hedgehope	2,347	Northumberland.
13	Ingleborough	2,361	Yorkshire.
14	Plinlimmon	2,463	Cardiganshire,
15	Cradle Mountain	2,545	Brecknockshire.
16	Coniston Fell	2,577	Westmoreland.
17	Caermarthen Van	2,596	Caermarthenshire.
18	Cheviot	2,658	Northumberland.
19	Grassmere Fell	2,755	Cumberland.
20	Arrenig	2,809	Merionethshire.
21	Crossfell	2,901	Cumberland.
22	Bowfell	2,911	....
23	Cader Idris	2,914	Merionethshire.
24	Arran-Fowddy	2.969	....
25	Helvelyn	3,055	Cumberland.
26	Skiddaw	3,022	....
27	Carnedd, Dafydd	3,427	Caernarvon.
28	Carnedd, Llewellyn	3,467	....
29	Snowdon	3,571	....
30	Cairngorm	4,050	Inverness-shire.
31	BEN MACDUI	4,418	Aberdeenshire.
32	Ben Nevis	4,358	Inverness-shire.
33	Ben Lawers	3,944	Perthshire.
34	Bein More	3,903	Sutherlandshire.
35	Ben More	3,818	Perthshire.
36	Ben Gloe	3,724	....
37	Ben Wyvis	3,720	Ross-shire.
38	Ben Ledi	3,651	Perthshire.
39	Schehallien	3,613	....
40	Bein Deirg	3,550	....
41	Ben Ferkinich	3,482	....
42	Mount Battock	3,450	Kincardineshire.
43	Macgillicuddy's Reeks	3,410	Kerry, Ireland.
44	Scairsoch	3,400	Aberdeenshire.
45	Ben Cruachan	3,390	Argyleshire.
46	Ben Gurdy	3,364	Perthshire.
47	Ben Aan	3,301	....
48	Ben Voirlich	3,270	....
49	Ben Lomond	3,191	Stirlingshire.
50	Sleibh Dorin	3,150	Derry.
51	Ben Venue	3,000	Perthshire.
52	Black Larg	2,890	Ayrshire.
53	The Cobbler	2,863	Argyleshire.
54	Dollarburn	2,840	Peeblesshire.
55	Broad Law	2,800	....
56	Croagh Patrick	2,666	Mayo, Ireland.
57	Hartfell	2,635	Dumfriesshire.
58	Lowther Hill	2,522	Lanarkshire.
59	Morne Hills	2,500	Downshire.
60	Paps of Jura	2,470	Argyleshire.
61	Tintock	2,306	Lanarkshire.
62	Croaghan	1,850	Kinshelly.
63	Pentland Hills	1,700	Mid-Lothian.
64	Campsie Hills	1,500	Stirlingshire.
65	Eildon Hills	1,300	Roxburghshire.
66	Arthur Seat	822	Mid-Lothian.
67	Salisbury Craigs	560	....
68	Edinburgh Castle	434	....
69	Goatfell	2,945	Isle of Arran.
70	Snaefell	2,004	Isle of Man.
71	Dunnose	810	Isle of Wight.
72	Ailsa Craig	1,139	Firth of Clyde.
73	Bass Rock	400	Firth of Forth.

PHYSICS.

Introduction.

General definition.

TAKEN in its most enlarged sense, the word *Physics* comprehends the whole study of nature; and *Natural Philosophy* is a term of the same extent; but ordinary language, especially in Britain, employs both of these terms in a much narrower sense, which it is proper in this place to determine with some precision.

Particular explanation.

Under the article PHILOSOPHY, we gave a particular account of that view of nature in which the objects of our attention are considered as connected by causation; and we were at some pains to point out the manner in which this study may be successfully cultivated. By a judicious employment of the means pointed out in that article, we discover that the objects of our contemplation compose an universe, which consists, not of a number of independent existences solitary and detached from each other, but of a number of substances connected by a variety of relations and dependencies, so as to form a whole, which may with great propriety be called the System of Nature.

This assembling of the individual objects which compose the universe into one system is by no means the work of a hasty and warm fancy, but is the result of sober contemplation. The natural historian attempts in vain to describe objects, by only informing us of their shape, colour, and other sensible qualities. He finds himself obliged, in describing a piece of marble, for instance, to tell us that it takes a fine polish; that it strikes fire with steel; that it burns to quicklime; that it dissolves in aquafortis, and is precipitated by alkalies; that with vitriolic acid it forms gypsum, &c.; and thus it appears, that even the description of any thing, with the view of ascertaining its specific nature, and with the sole purpose of discrimination, cannot be accomplished without taking notice of its various relations to other things. But what do we mean by the nature of any thing? We are ignorant of its essence, or what makes it that thing and no other thing. We must content ourselves with the discovery of its qualities or properties; and it is the assemblage of these which we call its nature. But this is very inaccurate. These do not constitute its essence, but are the consequences of it. Yet this is all we shall ever know of its nature. Now the term property is nothing but a name expressing some relation which the substance under consideration has to other things. This is true of all such terms. Gravity, elasticity, sensibility, gratitude, and the like, express nothing but certain matters of fact, which may be observed respecting the object of our contemplation in different circumstances of situation with regard to other things. Our distinct notions of individuals, therefore, imply their relations to other things.

All parts of the universe connected in their various properties.

The slightest observation of the universe shows an evident connection between all its parts in their various properties. All things on this earth are connected with each other by the laws of motion and of mind. We are connected with the whole of the solar system by gravitation. If we extend our observations to the fixed stars, the connection seems to fail; but even here it may be observed. Their inconceivable distance, it is true, renders it impossible for us to obtain any *extensive* information as to their nature. But these bodies are connected with the solar system by the sameness of the light which they emit with that emitted by our sun or any shining body. It moves with the same velocity; it consists, in most of them at least, of the same colours; and it is reflected, refracted, and inflected, according to the same laws.

Primary objects of attention.

In this unbounded scene of contemplation, our attention will be directed to the different classes of objects nearly in proportion to the interest we take in them. There is nothing in which we are so much interested as our fellow men; and one of the first steps that we make in our knowledge of nature, is an acquaintance with them. We learn their distinctive nature by attending to their characteristic appearances; that is, by observing their actions. We observe them continually producing, like ourselves, certain changes in the situation or condition of surrounding objects; and these changes are evidently directed to certain ends which respect themselves. Observing this subserviency of the effects which they produce to their own accommodation, we consider this adjustment of means to ends as the effect of an intention, since we experience it to be so in our own case, where we are conscious of this intention, and of these its effects. We therefore interpret those actions of other men, where we observe this adjustment of means to ends, as marks or signs of intention to them similar to our own; and thus a quality, or power, or faculty, is supposed in them by means of its sign, although the quality itself is not immediately cognisable by our senses. And as this intention in ourselves is accompanied by perception of external objects, knowledge of their properties, desire of good, aversion to evil, volition and exertion, without all of which we could not or would not perform the actions which we daily perform, we suppose the same perception, knowledge, desire, aversion, volition, and exertion in them. Thus, by the constitution of our mind, we consider the employment of means, by which ends terminating in the agent are gained, as the natural signs of design or intention. Art, therefore, or the employment of means, is the natural sign of intention; and wherever we observe this adjustment of means to ends, we infer the agency of design.

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A small acquaintance with the objects around us, obliges us to extend this inference to a great number of beings besides our fellow men, namely, to the whole animal creation; for in all we observe the same subserviency to the ends of the agent in the changes which we find them continually producing in the objects around them. These changes are all adjusted to their own well-being. In every such case, therefore, we are forced, by the constitution of our own minds, to infer the existence of design or intention in these beings also. But in numberless changes produced by external objects on each other, we observe no such fitness in the effects, no such subserviency to the well-being of the agent. In such cases, therefore, we make no such inference of thought or design.

All ob s divided - to thin g and un thinkin beings.

Thus, then, there is presented to our observation an important distinction, by which we arrange all external objects into two classes. The first resembles ourselves, in giving external marks of that thought or intention of which we are conscious; and we suppose in them the other properties which we discover in ourselves, but cannot immediately observe in them, viz. thought, perception, memory, foresight, and all that collection of faculties which we feel in ourselves, and which constitute the animal. The other class of objects exhibits no such appearances, and we make no such inference. Hence we divide the whole of external nature into the classes of thinking and unthinking beings.

How w come tc e knowle of mind

Our first judgments about these classes will be very inaccurate; and we will naturally ascribe the differences, which we do not very well understand, to the differences in organical structure, which we very clearly observe. But when we have knocked down or perhaps smothered an animal, we find that it no longer gives the former marks of thought and intention, and that it now resembles the class of unthinking beings: and yet it still retains all that fitness of organical structure which it had before; it seems only to want the intention and the will. This obliges us to conclude that the distinction does not arise from a difference in organical structure, but from a distinct substance, common to all thinking beings, though separable from their organical frame. To this substance we ascribe thought, intention, contrivance, and all that collection of faculties which we feel in ourselves. To this substance in ourselves we refer all sensations, pleasures, pains, remembrances, desires, purposes; and to this aggregate, however imperfectly understood, we give the name mind. Our organical frame, which seems to be only the instrument of information and operation to the mind, we call our body.

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As the animating principle is not, like our body, the immediate object of the senses, we naturally conceive it to be a substance essentially different from those which are the objects of our senses. The rudest people have shown a disposition to form this conclusion. Observing that animal life was connected with breathing, it was natural to imagine that breathing was living, and that breath was life. It is a remarkable fact, that in most languages the term for expressing *breath* is at least one of the terms for expressing the soul; רוח, *πνευμα*, *spiritus*, in the Hebrew, Greek, and Latin, express both; *gheist* or *ghost*, in the Teutonic, comes from *gheisen*, to breathe or sigh; *dūcha* or *dūha*, the soul, in Sclavonic, comes from *duichat*, to breathe; so, in the Gaelic, does *anal* come from *anam*; and the same relation is found between the two words in the Malay and other eastern languages. We believe that most persons can recollect some traces of this notion in their early conceptions of things; and many, who do not consider themselves as uncultivated, believe that the soul quits the body along with the last breath. Amongst the Tartar nations hanging is regarded with particular horror, on account of the ungraceful and filthy exit which the soul is obliged to make from the body. But the observation of the same appearances of thought and intention in fishes, and other animals which do not breathe, would soon show that this was but a rude conception. Very little refinement indeed is necessary to convince us that air or breath cannot be the substance which thinks, wishes, and designs; and that the properties of this substance, whatever it is, must be totally different from, and incompatible with, any thing that we know of the immediate objects of our senses.

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Hence we are led to conclude that there are two kinds of substances in nature; one which is the principle of sensation, and therefore cannot be the object of our senses, any more than light can be the object of the microscope. This substance alone can feel, think, desire, and propose, and is the object of reflection alone. The objects of our senses compose the other class, and therefore can have none of the other properties which are not cognoscible by the senses. These have all the properties which our senses can discover; and we can have no evidence of their having any other, nor indeed any conception of their having them. This class is not confined to the unorganized masses of matter; for we see that the bodies of animals lose after death that organized form, and are assimilated to all the rest of unthinking beings. It has arisen from such views as this, that whilst all nations have agreed to call this class of objects by the name of body, which originally expresses our organical frame, some nations, farther advanced in cultivation or refinement, have contrived an abstract term to express this general substance of which all inanimate beings are composed. Such a term we have in the words *materies* and *ὑλη*.

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Matter, then, is that substance which is immediately cognoscible by our senses. Whatever, therefore, is not thus immediately cognoscible by our senses is not material, and is expressed by a negative term, and called *immaterial*; and hence it is that mind is said to be immaterial. It is of importance to keep in mind this distinction, though merely grammatical. Little more is necessary for detecting the sophisms of Helvetius, Mirabeau, and others, who have been anxious to remove the ties of moral and religious obligation, by lowering our conceptions of our intellectual nature. It will also serve to show how hastily *they* have formed their opinions, who have ascribed to the immediate agency of mind all those relations which are observed in the actions of bodies upon each other at a distance. The connecting principles of such relations *e distante*, if there be any such, are not the immediate objects of our senses; they are therefore immaterial. But it does not follow that they are minds. There may be many immaterial substances which are not minds. We know nothing of any object whatever, except by the observation of certain appearances, which suggest to our minds the existence and agency of its qualities or powers. Such phenomena are the natural signs of these qualities, and it is to such signs that we must always have recourse when we wish to conceive without ambiguity concerning them. What is the characteristical phenomenon of mind, or what is the distinguishing quality which brings it into view? It is intention; and it may be asserted with the utmost confidence, that we have no other mark by which mind is immediately suggested to us, or which would ever have made us suppose that there existed another mind besides our own. The phenomenon by which this quality is suggested to us is *art*, or the employment of means to gain ends; and the mark of art is the supposed conduciveness of these ends to the well-being of the agent. Where this train is not observed, design or intention is never thought of; and therefore where intention is not perceived in any immaterial substance, if any such has ever been observed, it is an abuse of language to call it mind. We do not think that even perception and intelligence entitle us to give the name mind to the substance in which they are inherent, because it is from marks of intention alone that we infer the existence of mind; and although these must be accompanied with perception and intelligence, it does not follow that the substance which can perceive and understand must also desire and propose. However difficult we may find it to separate them, they are evidently separable in imagination. And let not this assertion be too hastily objected to; for the separation has been made by persons most eminent for their knowledge and discernment. When Leibnitz ascribed to his *monades*, or what we call the ultimate *atoms* of matter, a perception of their situation in the universe, and a motion precisely suited to this perception, he was the farthest in the world from supposing them animated or endowed with minds. It is true, indeed, that others, who think and call themselves philosophers, are much more liberal in their application of this term. A modern author of great metaphysical eminence says, "I call that mind which moves, and that body which is moved." This class of philosophers assert that no motion whatever is begun except by the agency of an animating principle, which, after Aristotle, they call Nature, and which has in these days been exalted to the rank of a god. All this jargon, for it is nothing else, has arisen from the puzzle in which naturalists think themselves involved in attempting to explain the production of motion in a body at a distance from that body which is conceived as the cause of this motion. After having been reluctantly obliged, by the reasonings of Newton, to abandon their methods of explaining such phenomena by the impulses of an intervening fluid, nothing seemed left but the assertion that these motions were produced by minds, as in the case of our own exertions. These explanations, if they deserve the name, cannot be objected to in any other way than as an abuse of language, and as the introduction of an unmeaning jargon. We have, and can have, no notion of mind different from those of our

Introduction.

own minds; and we discover the existence of other minds, as we discover the existence of bodies, by means of phenomena which are characteristic of minds, that is, which resemble those phenomena that follow the exertion of our mental faculties, that is, by the employment of means to attain selfish ends; and where such appearances are not observed, no existence of a mind is inferred. When we see a man fall from the roof of a house, and dash out his brains on the pavement, we never ascribe this motion to his mind. Although the fitness of many of the celestial motions for most important purposes makes us suppose design and contrivance somewhere, and therefore a Supreme Mind, we no more think of inferring a mind in the earth from the fitness of its motions for purposes most beneficial to its inhabitants, than of inferring a mind in a bit of bread from its fitness for nourishing our bodies. It is not from the mere motions of animals that their minds are inferred, but from the conduciveness of these motions to the well-being of the animal.

The mind is not that which produces motion, but that which desires and wills.

The term mind, therefore, in the ordinary language of all men, is applied to what desires and wills at the same time that it perceives and understands. If we call that mind which produces motion, we must derive our notions of its qualities or attributes from observing their effects. We must therefore discover the general laws by which they act, that is, the general laws observed in those motions which we consider as their effects. Now these are the general laws of motion; and in none of these can we find the least coincidence with what we are accustomed to call the laws of mind. Nay, it has been the total want of similarity which has given rise to the distinction which all men, in all ages and countries, have made between mind and matter. This distinction is found in all languages; and it is an unpardonable liberty which men take with language when they use a term of distinction, a specific term, to express things of a different species. What these authors have been pleased to call mind, the whole world besides have called by another name, *force;* which, though borrowed from our own exertions, is yet sufficiently distinctive, and never leads us to confound things which are different, except in the language of some modern philosophers, who apply it to the laws of the agency of mind, and, when speaking of the force of motives, &c. commit the same mistakes which the followers of Aristotle commit in the use of the term mind. Force, in the language of these philosophers, means what connects the operations of mind; as mind, in the language of Lord Monboddo, is that which connects the operations of body.

The principle of motion is not distinct from matter and mind.

Those persons are not less to blame who consider this *Nature* of Aristotle, this principle of motion, as an existence or substance different both from matter and from the minds of intelligent creatures. Aristotle calls it in some places ὡσπερ ψυχη. He might with equal propriety, and equal consistency with his other doctrines, have called mind ὡσπερ τελος, or ὡσπερ δυναμις. Besides, we have no evidence for the separability of this ὡσπερ ψυχη from body, as we have for the separability of such minds as our own, the genuine ψυχαι. Nay, his whole doctrines, when maturely considered, assume their absolute inseparability.

Elemental minds an abuse of language.

This doctrine of elemental minds, therefore, as the immediate causes of the phenomena of the material world, is an abuse of language. It is a jargon; and it is a frivolous abuse, for it offers no explanation whatever. The phenomena are totally unlike the phenomena of ordinary minds, and therefore receive no explanation from them; and since our knowledge of these ὡσπερ or *quasi* minds must be derived entirely from the phenomena, it will be precisely the same, although we express it in common language. We shall not indeed raise the wonder of our hearers, as those do who fill the world with minds which they never suspected to exist; but, on the other hand, we shall not bewilder their imaginations, confound their ideas, and mislead their judgments.

Intro tion.

The n e and us t animal stincts.

Some philosophers have attended only to the appearances of fitness which are exhibited in every quarter of the universe; and, by arranging these into different classes, and interpreting them as indications of thought and intention, have acquired the knowledge of many classes of sentient and intelligent beings, actuated by propensities, and directed by reason. Whilst the contemplation of these appearances indicates thought and design in any individual of one of these classes, and brings its propensities and purposes of action, and the ends gained by these actions, into view, the contemplation of these propensities, purposes, and ends, occasions an inference of a much more general kind. All these intelligent beings give indications of knowledge and of power; but their knowledge bears, in general, no proportion to their power of producing changes in nature, and of attaining important ends; and their power is neither always, nor in the most important cases, the consequence of their knowledge. Where the effect of their actions is most eminently conducive to their most important interests, the power of attaining these valuable ends is generally independent of any attention to the fitness of the means, and the exertion is frequently made without even thinking of the important end. The well-being of the individual is secured against any danger from its ignorance, indolence, or inattention, by an instinctive propensity, which leads it to the performance of the necessary action, which is thus made immediately and ultimately desirable, without any regard to its ultimate and important end. Thus, in our own nature, the support of animal life, and the improvement of the means of subsistence by a knowledge of the objects which surround us, are not intrusted to our apprehensions of the importance of these ends, but are committed to the surer guides of hunger and curiosity.

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The same observers discover a connection between the individuals of a class, different from that which arises from the mere resemblance of their external appearance, or even of their propensities and pursuits; the very circumstances which produced the classification. They observe, that these propensities are such, that whilst each individual seeks only its own enjoyment, these enjoyments are in general such as contribute to the support of the species, and the enjoyment of other individuals. Thus, in the classes of animals, and in human nature, the continuance of the race, and the enjoyment of the whole, are not intrusted to the apprehension we entertain of the importance of these ends, but are produced by the operation of sexual love and the love of society.

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The same observers find that even the different classes of sentient beings are connected together; and whilst the whole of each class aim only at their own enjoyment, they contribute, in some way or other, to the well-being of the other classes. Even man, the selfish lord of this sublunary world, is not the unconnected inhabitant of it. He cannot, in every instance, reap all the fruits of his situation, without contributing to the enjoyment of thousands of the brute creation. Nay, it may be proved to the satisfaction of every intelligent man, that whilst one race of animals, in consequence of its peculiar propensities, subsists by the destruction of another, the sum total of animal life and enjoyment is prodigiously increased.[1]

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[1] See a very judicious dissertation on this curious and puzzling subject, entitled a Philosophical Survey of the Animal Creation; where it appears that the increase of animal life and enjoyment which is produced by this means, beyond what could possibly obtain without it, is beyond all conception. See likewise the edition of King's Origin of Evil, by Dr Law.

Thus the whole assemblage seems connected, and jointly employed in increasing the sum total of possible happiness. This fitness of the various propensities of sentient and intelligent beings, this subserviency to a general purpose, strikes these observers as a mark of intention, evidently distinct from, and independent of, all the particular intentions, and superior to them all; and thus it irresistibly leads them to infer the existence of a Supreme Mind, directing the whole of this intellectual system, whilst the individuals of which it consists appear the unconscious instruments in the hand of a great Artist, with which he executes his grand and beneficent purposes.

But the observation extends yet further. The bodies of the inanimate creation are not only connected with each other by a mutual dependence of properties, and the relation of causation, but they are also connected with the sentient beings by a subserviency to their purposes of enjoyment. The philosopher observes that this connection is admirably kept up by the constancy of natural operations and the expectations of intelligent beings. Had either of these circumstances been wanting, had either the operations of nature been without rule, or had sentient beings possessed no perception or expectation of their uniformity, the subserviency would be totally at an end. This adjustment, this fitness, of which the result is the enjoyment of the sentient inhabitants of the universe, appears to be the effect of an intention of which this enjoyment is the final cause. This constancy, therefore, in the operations of nature, both in the intellectual and material world, and the concomitant expectation of sentient beings, appear to be the effects of laws imposed on the different parts of the universe by the Supreme Mind, who has formed both these classes of beings so admirably suited to each other.

To such observers the world appears a work of art, a system of means employed for gaining certain proposed ends, and it carries the thoughts forward to an artist; and we infer a degree of skill, power, and good intention in this artist, proportioned to the ingenuity, extent, and happy effect which we are able to discern in his works. Such a contemplation of nature, therefore, terminates in natural theology, or the discovery of the existence and attributes of God.

Our notions of this Supreme Mind are formed from the indications of design which we observe, and which we interpret in the same way as in the actions of men. These notions therefore will differ from our notions of other minds only in the degrees which we are able to observe, and which we assign to these faculties; for the phenomenon or the effect is not only the mark, but also the measure of its supposed cause. These degrees must be ascertained by our own capacity of appreciating the extent, the multiplicity, and the variety of the contrivance. Accordingly, the attributes of the Supreme Mind, in the theological creed of a rude Indian, are much more limited than in that of a European philosopher. In proportion as our understandings are enlarged, and as our acquaintance with the operations of nature around us is extended, we shall perceive higher degrees of power, of skill, and of kind intention; and since we find that the scene of observation is unbounded, we cannot affix any boundaries to these attributes in our own imagination, and we are ready to suppose that they are infinite or unbounded in their own nature. When our attentive survey of this universe, and a careful comparison of all its parts, as far as we can understand or appreciate them, have made us conclude that it is one design, the work of one artist, we are under the necessity of inferring, that, with respect to this universe, his power, wisdom, and benevolence, are indeed infinite.

When men have been led to draw this conclusion from the appearances of fitness which are observed everywhere around them, they consider that constancy which they observe in natural operations, whether in the material or the intellectual system, and that expectation of and confidence in this constancy, which renders the universe a source of enjoyment to its sentient inhabitants, as the consequences of laws imposed by the Almighty Artist on his works, in the same manner as they would consider the constancy in the conduct of any people as the consequences of laws promulgated and enforced by the supreme magistrate.

The rise of moral sentiments and of moral duty.

There can be no doubt of this view of nature being extremely captivating, and likely to engage the curiosity of speculative men; and it is not surprising that the phenomena of mind have been keenly studied in all ages. This part of the study of nature, like all others, was first cultivated in subserviency to the wants of social life; and the general laws of moral sentiment were the first phenomena which were considered with attention. This gradually ripened into a regular system of moral duty, accompanied by its congenial study, the investigation or determination of the *summum bonum*, or the constituents of human felicity; and these two branches of intellectual science were always kept in a state of association by the philosophers of antiquity. Jurisprudence, the science of government, legislation, and police, were also first cultivated as arts, or at least in immediate subserviency to the demands of cultivated society; and all these so nearly related parts of the study of human nature had made a very considerable progress, in the form of maxims or precepts for directing the conduct, before speculative men, out of mere curiosity, treated them as subjects of philosophical study. Our moral sentiments, always involving a feeling of obligation, are expressed in a language considerably different from the usual language of pure philosophy, speaking of things which ought to be, rather than of things which are; and this distinction of language was increased by the very aim of the writers, which was generally to influence the conduct as well as the opinions of their scholars. It was reserved for modern times to bring this study into the pure form of philosophy, by a careful attention to the phenomena of moral sentiment, and classing these according to their generality, and ascertaining their respective ranks by an appeal to experiment, that is, to the general conduct of mankind; and thus it happens that in the modern treatises on ethics, jurisprudence, &c. there is less frequent reference made to the *officia* or duties, that is, the constituents of the *summum bonum*, than amongst the ancients, and a more accurate description of the human mind, and discrimination of its various moral feelings.

The origin of logic and other intellectual sciences.

It was hardly possible to proceed far in these disquisitions without attending to the powers of the understanding. Differences of opinion were supported by reasonings, or attempts at reasoning. Both sides could not be in the right, and there must be some court of appeal. Rules of argumentation behoved to be acquiesced in by both parties; and it could hardly escape the notice of some curious minds, that there were rules of truth and falsehood as well as of right and wrong. Thus the human understanding became an object of study, first in subserviency to the demands of the moralist, but afterwards for its own sake; and it gradually grew up into the science of logic. Still further refinement produced the science of metaphysics, or the philosophy of universals. But all these were in fact posterior to the doctrines of morals; and disquisitions on beauty, the principles of taste, the precepts of rhetoric and criticism, were the last additions to the study of the phenomena of mind. And now, since the world seems to have acquiesced in the mode of investigation of general laws by experiment and observation, and to agree that this is all the knowledge which we can acquire of any subject whatever, it is to be expected that this branch of philosophical discussion will attain the same degree of improvement (estimated by the coincidence of the doctrines with fact and experience) that has been attained by some others.

The partial practice of natural philosophy preceded its study as a science.

The occupations, however, of ordinary life have oftener directed our efforts towards material objects, and engaged our attention on their properties and relations; and as all sciences have arisen from arts, and were originally implied in the maxims and precepts of those arts, until separated from them by the curious speculatist, the knowledge of the material system of nature was possessed in detached scraps by the practitioners in the various arts of life long before the natural philosopher thought of collecting them into a body of scientific doctrines. But there have not been wanting in all ages men of curiosity, who, having been struck by the uniformity of the operations of nature in the material world, were eager to discover their causes. Accordingly, whilst the moralists and metaphysicians turned their whole attention to the phenomena of mind, and produced the sciences of pneumatology, logic, ethics, jurisprudence, and natural theology, these observers of nature found sufficient employment in considering the phenomena of the material world.

The nature of the material system.

The bodies of which it consists are evidently connected by means of those properties by which we observe that they produce changes in each other's situations. This assemblage of objects may therefore be justly called a system. We may call it the material system. It is frequently termed nature; and the terms natural appearances, natural causes, natural laws, have been generally restricted to those which take place in the material system. This restriction, however, is improper, because there is no difference in the manner in which we form our notions of those laws, and reason from them, with respect both to mind and to body; or if there is to be any restriction, and if any part of the study of the universe is to be excluded in the application of these terms, it is that part only which considers moral obligation, and rather treats of what ought to be than of what actually is. As has already been observed, there is a considerable difference in the language which must be employed; but still there is none in the principles of investigation. We have no proof for the extent of any moral law but an appeal to the feelings of the hearts of men, indicated by the general laws or facts which are observed in their actions.

The unrestricted sense in which some of these terms are used, and its consequences.

But this is only a question of the propriety of language. And no great inconvenience would arise from the restriction now mentioned if it were scrupulously adhered to; but unfortunately this is not always the case. Some authors use the term *natural law* to express *every* coincidence of fact; and this is certainly the proper use of the term. The French writers generally use the term *loi physique* in this enlarged sense. But many authors, misled by, or taking advantage of, the ambiguity of language, after having established a law founded upon a copious and perhaps unexcepted induction of the phenomena of the material system (in which case it must be considered in its restricted sense), have, in their explanation of phenomena, extended their principle much farther than the induction on which they had founded the existence of the physical law. They have extended it to the phenomena of mind, and have led their followers into great and dangerous mistakes. Languages, like every other production of human skill, are imperfect. They are deficient in terms, and are therefore figurative. The most obvious, the most frequent, and the most interesting uses of language, have always produced the appropriate terms, and the progress of cultivation has never completely supplied new ones. There are certain analogies or resemblances, or certain associations of ideas, so plain that a term appropriated to one very familiar object will serve to suggest another analogous to it, when aided by the concomitant circumstances of the discourse; and this with sufficient precision for the ordinary purposes of social communication, and without leading us into any considerable mistakes; and it is only the rare and refined disquisitions of the curious speculatist that bring the poverty and imperfection of language into view, and make us wish for words as numerous as our thoughts. There is hardly a sentence, even of common discourse, in which there are not several figures either of single words or of phrases; and when very accurate discrimination is required, it is almost impossible to find words or phrases to express distinctions which we clearly feel. We believe it impossible to express, by the scanty vocabulary of the Hebrews, the nice distinctions of thought which are now familiar to the European philosopher. In nothing does this imperfection of language appear so remarkably as in what relates to mind. Being a late subject of separate discussion, and interesting only to a few speculatists, we have for it no appropriate vocabulary; and all our disquisitions concerning its operations are in continual metaphor or figure, depending on very slight analogies or resemblances to the phenomena of the material world. This renders the utmost caution necessary; and it justifies the British philosophers, who have been the most successful in prosecuting the study of the intellectual system, for having, almost without exception, restricted the terms natural laws, natural causes, natural philosophy, and such like, to the material system. With us pneumatology forms no part of physics. And we may venture to affirm, that the sciences have fared better by the restriction of the terms. In no country has the spirit of liberal discussion been more encouraged and indulged than in Britain, and her philosophers have been equally eminent in both branches of science. Their performances in ethics, jurisprudence, and natural theology, are considered by all our neighbours as the fountains of knowledge upon these subjects; and Locke and Clarke are names not less familiar on the continent than that of Newton.

The t *physic* fined t is gen ly und stood Britai

Physics, then, is with us the study of the material system, including both natural history and philosophy. The term is not indeed very familiar in our language; and instead of *physicus* and *disciplina physica*, we more generally employ the terms naturalist and natural knowledge. The term natural philosophy, in its common acceptation, is of less extent. The field of physical investigation is still of prodigious extent; and its different quarters require very different treatment, make very different returns, and accordingly have engaged in their particular cultivation persons of very different talents and tastes. It is of some importance to perceive the distinctions, and to see how the wants and propensities of men have led them into the different paths of investigation; for, as has been more than once observed, all sciences have sprung from the humble arts of life, and both go on improving by means of a close and constant correspondence.

The p nomen of the m rial sy m.

All the phenomena of the material system may be arranged into two classes, distinguished both by their objects and by the proper manner of treating them. The first class comprehends all the appearances which are exhibited in the *sensible motions* of bodies, and their actions on each other producing *sensible motion*. The second class comprehends the appearances which are exhibited in the *insensible* motions and actions of the invisible particles of matter.

Exam s of th of the fi and se nd class.

Of the phenomena of the first class we have examples in the planetary motions, the motions of heavy bodies, the phenomena of impulse, the motions and actions of machines, the pressure and motions of fluids, the sensible actions of magnetical and electrical bodies, and the motions of light. We have examples of the second class in the phenomena of heat and mixture, those exhibited in the growth of animals and vegetables, and many phenomena oduc- on.

Introduction.

of solid, fluid, magnetical, electrical, and luminous bodies, in which no change of place can be observed.

ar- ement parent- tural.

Thus it appears that there is a distinction in the phenomena sufficiently great to warrant a division of the study, and to make us expect a more rapid improvement by this division. Nay, the division has been made by nature itself, in the acquaintance which men have attained with her operations without study, before science appeared, and whilst art constituted all our knowledge.

origin ricul- phy- ur- and istry.

Before man had recourse to agriculture, as the most certain means of procuring subsistence, our acquaintance with external substances was principally that of the natural historian; consisting of a knowledge of their fitness for food, medicine, or accommodation, their places of growth or habitation, and the means of procuring them, depending upon their manner of life or existence. It required a studied attention to these circumstances to give rise to agriculture, which therefore generally made its appearance after men had been in the practice of keeping flocks; by which means they were more at their ease, and had some leisure to attend to the objects around them, and in particular to those circumstances of soil and weather which affected the growth of their pasture.

When agriculture and a rude medicine were thus established, they were the first arts which had their foundation in a system of laws, by which the operations of nature were observed to be regulated; and with these arts we may begin the *general study of nature*, which was thus divided into two different branches. The rude physician would at first be a collector of specifics; but by degrees he would observe resemblances amongst the operations of his drugs, and would class them according to these resemblances. He would thus come to attend less to the drug than to its mode of operation; and would naturally speculate concerning the connection between the operation and the economy of animal life. His art now became a scientific system, connected by principle and theory, all proceeding upon the observation of changes produced by one kind of matter on another, but all out of sight. The frequent recourse to the vegetable kingdom for medicines would cause him to attend much more minutely to the few plants which he had occasion to study than the husbandman can do to the multitude which he is obliged to rear. The physician must learn to think, the husbandman to work. An analogy between the economy of animal and vegetable life could hardly fail to engage the attention of the physician, and would make him a botanist, both as a classifier of plants and as a philosopher.

He would naturally expect to unite the services of his drugs by combining them in his recipes, and would be surprised at his disappointments. Curious and unexpected changes would frequently occur in his manipulations: the sensible qualities, and even the external appearances, of his simples, would be often changed and even inverted by their mixture; and their medicinal properties would frequently vanish from the compound, and new ones be induced. These were curious, and to him interesting facts; and he would naturally be inquisitive after the principles which regulated these changes. His skill in this would by degrees extend beyond the immediate use for the knowledge of them; and the more curious speculatist would lay the foundations of a most extensive and important science, comprehending all the phenomena of heat and mixture.

Along with this, and springing from the same source, another science must arise, contemplating the appearances of animal and vegetable life, and founded upon a careful observation and accurate description of the wonderful machine. The most incurious of men have in all ages been affected by the displays of wisdom and contrivance in the bodies of animals, and immediately engaged in investigation into the uses and functions of their various parts and organs. The phenomena have been gradually discriminated, and arranged under the various heads of nutrition, concoction, secretion, absorption, assimilation, rejection, growth, life, decay, disease, and death; and, in conformity to the doctrines which have with greater or less evidence been established on these subjects, the action of medicines, and the whole practice of physic and surgery, has been established in the form of a liberal or scientific art.

The origin of the knowledge of the mechanical powers.

The husbandman, in the mean time, must till or labour the ground which lies before him. He, too, is greatly interested in the knowledge of the vegetable economy, and forms some systems on the subject by which he regulates his labours; but he sees, that whatever is the nature of vegetable life, he must work hard, and he searches about for everything which can tend to diminish his labour. The properties of the lever, the wedge, and the inclined plane, soon become familiar to him; and, without being able to tell on what their efficacy depends, he uses them with a certain sagacity and effect. The strength of timber, the pressure and force of water, are daily seen and employed by him and other artisans who labour for their mutual accommodation; and some rude principles on these subjects are committed to memory. Many tools and simple machines are by this time familiar; and thus the *general properties* of matter, and the general laws of the actions of bodies upon each other, become gradually matter of observation and reflection; and the practical mechanic will be frequently improving his tools and machines. The general aim is to produce a greater quantity of work by the same amount of exertion. The attempts at improvement will be awkward, and frequently unsuccessful. When a man finds, that by increasing the length of his lever he increases his power of overcoming a resistance, a small degree of curiosity is sufficient to make him inquire in what proportion his advantage increases. When he finds that a double length gives him a double energy, he will be surprised and mortified to find, that at the end of the day he has not performed twice the quantity of work; but, after much experience, he will learn that every increase of energy, by means of a machine, is nearly compensated by an increase of time in the performance of his task; and thus one of the great and leading principles of practical mechanics is inculcated in a manner not to be forgotten, and the practical mechanic brought to speculate about motion and force; and by gradual and easy steps the general laws of simple motions are established.

The origin of mathematics.

It is evident that these speculations cannot be carried on, nor any considerable knowledge acquired, without some acquaintance with the art of measurement; and the very questions which the mechanic wishes to solve presuppose some advances in this art, which in process of time refined itself into mathematics, the most perfect of all the sciences. All the phenomena of sensible motion afford employment to the mathematician. It is performed in a double or triple time, through a double or triple space, by a double or triple body, by the exertion of a double or triple force; produces a double or triple effect; is more to the right or to the left, upwards or downwards, &c.; in short, every affection of motion is an object of mathematical discussion. Such a science must have ere now appeared in the form of an art, in consequence of the mutual transactions of men. These amongst an uncultivated people are chiefly in the way of barter. If I want corn from a peasant, and have nothing to give for it but the cloth which I have made, we must fall on some way of adjusting our terms in respect of the quantity. We should soon discover that the length, and breadth, and depth of the box or bag were equally important; and it would not be difficult to see, that if any of them were doubled or tripled, the quantity of grain would be so too; if two of them were doubled, the grain would be quadrupled; and if all the three were doubled the quantity of grain would be increased eight times. The same thing would also be observed with respect to my cloth. By such transactions as these, a few of the properties of plane and solid numbers and figures would become known, and the operations of multiplication and division, where arithmetic is combined with geometry; and daily observation shows us, that the more abstruse properties of number and figure, which to the generality of mankind are so insignificant, lay hold on the fancy of some individuals with such force, as to abstract them from every other intellectual entertainment, and they are studied with a keenness and perseverance almost unequalled in any other walk of science. To most men the performance of a machine is a more attractive object than the properties of a figure, and the property of a figure more entertaining than that of a number; but the fact seems to be otherwise. Before Pythagoras had invented the theorem which bears his name, and which is amongst the first elements of geometry, he had reformed the Grecian music by the addition of a note to their scale; and this addition proceeds on a very refined speculation respecting the properties of numbers. Hence amongst the Greeks arithmetic must have made considerable progress, whilst geometry was yet in its cradle; and we know to what astonishing length they prosecuted the science of pure geometry, whilst their knowledge of mechanical principles was almost nothing. The Arabs also made hardly any addition to the geometry of the Greeks, if they did not rather almost completely forget it; whilst they improved their arithmetic into algebra, the most refined and abstract branch of human knowledge. There is such a distance, in point of simplicity, between pure mathematics and the most elementary mechanics, that the former continued to make rapid steps to improvement in more modern times, whilst the latter languished in its infancy, and hardly deserved the name of science till latterly, when the great demand for it, by the increase and improvement in manufactures, interested many in the study, and facilitated its progress, by the multitude of machines which were contriving on all hands by the manufacturers and artisans: and even at present it must be acknowledged, that it is to them that we are indebted for almost every new invention in mechanics, and that the speculatist has seldom done more than improve the invention, by exhibiting its principles, and thus enabling the artist to correct its imperfections; and now science and art go hand in hand, mutually giving and receiving assistance. The demands of the navigator for mathematical and astronomical knowledge have dignified these sciences; and they are no longer the means of elegant amusement alone, but merit the munificence of princes, who have erected observatories, and furnished voyages of discovery, where the mathematical sciences are at the same time cherished, and applied to the most important purposes.

This short sketch of what may be called *the natural history of the physical sciences* will not, we hope, be thought improper or unprofitable. It tends to confirm an assertion often alluded to, that the prosecution of the study of nature will be more successful, if we imitate her mode of proceeding, and divide the labour. It will be still further confirmed by attending to the scientific difference of the phenomena, which marks out a different mode of proceeding, and a difference in the knowledge which we shall ultimately acquire, after our most successful researches.

The connecting principle of concomitant events.

In both classes of phenomena already distinguished, we must grant, that the principle which connects the pairs of concomitant events, rendering the one the inseparable companion of the other, is totally unknown to us, because it is not the immediate object of our perception. But in the phenomena of the first class, we see the immediate exertion of this principle, whatever it may be; we can observe the exertion with accuracy; we can determine its kind and degree, which are the signs and measures of the kind and degree of the unperceived cause. This exertion, being always some modification of motion, allows us to call in the aid of mathematical knowledge, and thus to ascertain with the precision peculiar to that science the energy of the cause, judging of the tendency and quantity by the tendency and the quantity of the observed effect. But in the second class of phenomena the case is very different. In the operations of chemistry, for instance, the *immediate* exertion of the cause is not perceived; all that we observe is the assemblage of particles which obtains before mixture, and that which takes place when it is completed, and which we consider as its result. The procedure of nature in producing the change is unseen and unknown. The steps are hid from our observation. We are not only ignorant of the cause which determines one particle of our food to become a part of our body whilst others are rejected, but we do not see the operation. We are not only ignorant of the cause which determines a particle of vitriolic acid to quit the fossil alkali with which it is united in Glauber's salt, and to attach itself to a particle of magnesia already united with the muriatic acid, which also quits it to unite with the alkali; but we do not see the operation. The particles and their motions are not the objects of our senses; and all that we see is the Epsom salt and common salt separated from the water in which we had formerly dissolved the *sal mirabile* and the muriated magnesia. The motions, which are the *immediate* effects of the changing causes, and therefore their only indications, characteristics, and measures, fitted to show their nature, are hidden from our view.

The phenomena of the second class; less understood.

Our knowledge therefore of these phenomena must be less perfect than that of the phenomena of the former class; and we must here content ourselves with the discovery of more remote relations and remote causes, and with our ignorance of the very powers of nature by which these changes are brought about, and which are cognoscible only by their immediate effects, namely, the motions which they produce unseen. The knowledge which we really do acquire is somewhat similar to what the mechanical philosopher has acquired when he has discovered, by many experiments and investigations, that magnets attract each other by their dissimilar, and repel each other by their similar poles, and do not act at all upon any bodies except loadstones and iron. Here we leave undiscovered all that is most curious in the phenomenon, namely, how these attractions and repulsions are produced; and even here the magnetical philosopher has the advantage of seeing the agents and the operation.

Some philosophers have attempted to explain the phenomena by the doctrine of motion.

But philosophers attending to this circumstance, that, even in these cases, the changes are produced by motions, or consist in motions, however unperceived these may be, have concluded, that the laws according to which nature operates in producing these changes are similar to the laws which regulate her operations in the sensible actions of bodies, or are included in them; and that the motions, although unseen, and the moving forces, are perfectly similar. They have therefore employed similar modes of investigation, applying the laws of impulse, and calling in the aid of mathematical knowledge. Of this we have many examples in the writings of Dr Freind, Keill, Bernoulli, Helsham, Boerhaave, Hartley, and others, who have delivered theories of fermentation, solution, precipitation, crystallization, nutrition, secretion, muscular action, nay, even of sensation and intelligence, founded, as they think, upon the laws of motion, and illustrated and supported by mathematical reasoning. Lord Bacon himself, that careful and sagacious distinguisher of intellectual operations, has gone into the same track in his explanation of the phenomena of fire and combustion; and Sir Isaac Newton has made several attempts of the same kind, although with peculiarities which always characterize his discussions, and render them very different from those of an inferior class.

But the success of these philosophers has hitherto been very discouraging; indeed they had no title to expect any; for their whole trains of reasoning have proceeded upon analogies which were not observed, but assumed or *supposed* without any authority. There is not that similarity in the phenomenon, or in the visible effect, which is absolutely necessary for a successful reasoning by analogy. We do not observe any local motion, any change of place, which alone enables us to reason mathematically on the subject. And to render the case desperate, this ill-founded analogy has been mixed with hypotheses completely gratuitous. Certain forms have been assigned to the particles, and certain modes of action have been laid down for them, for the reality of which we have not the least argument or indication; and, to complete the matter, these fancied forms and laws of action have been such as are either self-contradictory and inconsistent, or they have been such as, if allowed to act in a way analogous to what we observe in the sensible motions of bodies, would produce effects totally different from those which are observed. These atomical theories, as they are called, transgress every rule of philosophical discussion; and even the best of them are little better than trifling amusements. By far the greatest part of them only serve to raise a smile of pity and contempt in every person who is at all acquainted with mechanical philosophy. Whenever we see an author attempting to explain these hidden operations of nature by invisible fluids, by ethers, by collisions, and vibrations, and particularly if we see him introducing mathematical reasonings into such explanations, the best thing we can do is to shut the book, and take to some other subject. That we may not be thought to speak presumptuously upon this occasion, we only beg leave to remind our readers, that the united knowledge of the most eminent mathematicians of Europe has not yet been able to give any thing more than an approximation to the solution of the problem of three bodies, that is, to determine with accuracy the motions of three particles of matter acting on each other in the simplest of all possible manners, viz. by forces varying as the squares of the distances inversely; and the vibrations of elastic bodies, of any but the very simplest possible forms, are to this day beyond the reach of investigation. What then should be our expectations in cases where millions of particles are acting at once, of forms unobserved, and with forces unknown, and where the object is not a determination of an average result of many, where the precise state of an individual article need not be known, but where it is this very precise state of each single particle that we want to know? What can it be but uncertainty and mistake?

Notwithstanding these discouraging circumstances, we must observe that this kind of inquiry has greatly improved, alongst with the improvement and extension of mathematical philosophy, and since philosophers have given over their incessant attempts to explain everything by impulse; and we need not despair of making still further advances, if we will content ourselves with going no farther than Newton has done in his explanation of the planetary motions. He has immortalized his own name, and has added immensely to our stock of useful knowledge; yet he has stopped short at the discovery of the fact of universal gravitation; and all who have endeavoured to explain or account for this fact have only exposed themselves to pity. We may perhaps be one day able to demonstrate from the phenomena that the particles of matter have certain mutual tendencies to or from each other, exerted according to fixed or invaried rules; and from these tendencies we may be able to explain many other phenomena, and predict the consequences, with as much certainty and evidence as an astronomer calculates a future eclipse. This would be a great acquisition, and perhaps more is impossible; and the road to this has been indicated by Sir Isaac Newton, who has expressed his suspicion, that as the great movements of the solar system are regulated by universal gravitation, so the mutual actions of the particles of matter are produced and regulated by tendencies of a similar kind, *equally* but not *more* inexplicable, and of which the laws of action are to be discovered by as careful an attention to the phenomena, and by the same patient thinking, which he has employed on the planetary motions.

The particular divisions of physical science in Britain.

The above distinction in the nature of the phenomena, the difference in the nature of the knowledge which is to be acquired, and the means which are to be employed for the successful prosecution of the two branches of general physics, have occasioned a still farther restriction (at least in Britain) of the term *Natural Philosophy*. It is particularly applied to the study of the phenomena of the first class, whilst those of the second have produced the sciences of *Chemistry* and *Physiology*.

The phenomena of the first class have been usually called *mechanical*, in order to distinguish them from those observed in the operations of chemistry, and in the animal and vegetable economy; and the explanations which have been attempted of some of the last, by applying the laws observed in the phenomena of the first class, have been called *mechanical explanations*.

As this first class is evidently but a part of general physics, there is some impropriety in giving the name *natural philosophy* to a course of doctrines which is confined to these alone. Indeed at the first institution of universities, the lectures given in the *Schola Physica* were much more extensive, comprehending almost all the phenomena of the material world; but as all arts and sciences have improved most where the labour has been most divided, it was found more conducive to the advancement of knowledge that separate institutions should be founded for the studies of natural history, chemistry, physiology, &c.; and thus the phenomena, purely mechanical, and a few others in magnetism, electricity, and optics, which either were susceptible of mathematical treatment, or had little connection with the studies of chemistry and physiology, were left to the care of the professor of natural philosophy.

As the terms *chemistry* and *physiology* have been applied to two very important branches of general physics, we think that a more specific or characteristic name might be appropriated to the other, and that it might very properly be termed *Mechanical Philosophy*.

It only remains to make a few observations on the distinctive means of prosecuting these studies with success; and to point out some of the advantages which may reasonably be expected from a careful prosecution of them; but in doing so, we shall confine ourselves to what is usually called *Natural Philosophy*, referring generally to the articles CHEMISTRY and PHYSIOLOGY for what belongs to these branches.

Mechanical philosophy defined.

MECHANICAL PHILOSOPHY may, in conformity with the foregoing observations, be defined, the study of the sensible motions of the bodies of the universe, and of their actions producing sensible motions, with the view to discover their causes, to explain subordinate phenomena, and to improve art.

The principle upon which all philosophical discussion proceeds is, that every change which we observe in the condition of things is considered by us as an effect, indicating the agency, characterizing the kind, and measuring the degree of its cause. In the language of mechanical philosophy, the cause of any change of motion is called a moving or changing *force*. The disquisitions of natural philosophy must therefore begin with the consideration of motion, carefully noticing every affection or quality of it, so as to establish marks and measures of every change of which it is susceptible; for these are the only marks and measures of the changing forces. This being done, it only remains to apply them to the motions which we observe in the universe.

The laws of motion, and their application.

From the general principle of philosophical discussion already mentioned, there flow directly two axioms. 1. Every body perseveres in a state of rest, or of uniform rectilineal motion, unless affected by some moving force. 2. Every change of motion is in the direction and in the degree of the force impressed. These are usually called the *laws of motion.* They are more properly laws of human judgment with respect to motion. Perhaps they are necessary truths, unless it be alleged that the general principle, of which they are necessary consequences, is itself a contingent though universal truth. By these two axioms, applied *in abstracto* to every variety of motion, we establish a system of general doctrines concerning motions, according as they are simple or compounded, accelerated, retarded, rectilineal, curvilineal, in single bodies, or in systems of connected bodies; and we obtain corresponding characteristics and measures of accelerating or retarding forces, centripetal or centrifugal, simple or compound.

We have an illustrious example of this abstract system of motion and moving forces in the first book of Sir Isaac Newton's Mathematical Principles of Natural Philosophy. Euler's *Mechanica sive Scientia Motus*, Herman's *Phoronomia sive de Viribus Corporum*, and D'Alembert's *Traité de Dynamique*, are also excellent works of the same kind. In this abstract system no regard is paid to the casual differences of moving forces, or the sources from which they arise. It is enough to characterize a double accelerating force, for instance, that it produces a double acceleration. It may be a weight, a stream of water, the pressure of a man; and the force of which it is said to be double may be the attraction of a magnet, a current of air, or the action of a spring.

Having established these general doctrines, the philosopher now applies them to the *general* phenomena of the universe, in order to discover the nature of the forces which really exist, and the laws by which their operations are regulated, and to explain interesting but subordinate phenomena. This is the chief business of the mechanical philosopher; and it may with some propriety be called the *mechanical history of nature.*

Mechanical phenomena of the universe.

Some method must be followed in this history of mechanical nature. The phenomena must be classed by means of their resemblances, which infer a resemblance in their causes; and their classes must be arranged according to some principle. We have seen no method which appears to us less exceptionable than the following.

The generality of the phenomena the principle of arrangement.

The principle of arrangement is the generality of the phenomena; and the propriety of adopting this principle arises from the probability which it gives us of more readily discovering the most general actuating forces, whose agency is implicated in all other phenomena of less extent, and therefore should be previously discussed, that we may detect the discriminating circumstances which serve to characterize the subordinate phenomena, and are thus the marks of the distinguishing and inferior natural powers.

The laws of motion are first applied to astronomical phenomena.

The most general of all phenomena is the curvilineal motion of bodies in free space; it is observed throughout the whole extent of the solar system. The mechanical history of nature begins therefore with astronomy. Here, from the general phenomena of the planetary motions, is evinced the fact of the mutual deflection of every body towards every other body, and this in the inverse proportion of the squares of the distance, and the direct proportion of the quantity of matter. This is the fact of *universal gravitation*, indicating the agency, and measuring the intensity, of the universal force of mutual gravity.

Having established this as an universal fact, the natural philosopher proceeds to point out all the particular facts which are comprehended under it, and the peculiarities of which characterize the different movements of the solar system. That is, in the language of philosophy, he gives a theory or explanation of the subordinate phenomena, the elliptical motions of the planets and comets, their mutual disturbances, the lunar irregularities, the oblate figure of the planets, the nutation of the earth's axis, the precession of the equinoxes, and the phenomena of the tides and trade winds; and he concludes with the theory of the parabolic motion of bodies projected on the surface of this globe, and the motion of pendulums.

As he goes along, he takes notice of the applications which may be made to the arts of life, of the various doctrines which are successively established; such as chronology, astronomical calculation, dialling, navigation, gunnery, and the measuring of time.

If a square parcel of sand be lying upon the table, and the finger be applied to any part of it to push it along the table, that part is removed where you will, but the rest remains in its place; but if it be a piece of sand-stone of the same materials and shape, and the finger be applied as before, the whole is moved, and the other parts accompany the part impelled by the finger in all its motions. From the moon's accompanying the earth in all its motions round the sun, we infer a moving force which connects the moon and earth. In like manner we must conclude, that a moving force connects the particles of the stone; for we give the name *force* to everything which produces motion. We call it the force of *cohesion*, a term which, like gravitation, expresses merely a fact. This seems to be the next phenomenon of the universe in point of extent.

Having, from the general phenomenon, established the existence of this force, the philosopher proceeds to ascertain the laws by which its exertions are regulated; which is the ascertaining its distinctive nature and properties. This he does in the same way that he ascertained the nature of planetary gravitation, namely, by observing more particularly the various phenomena. Here is opened a most extensive and varied field of observation, in which it must be acknowledged that very little regular and marked progress has been made. The variety of the phenomena, and the consequent variety in the nature of the connecting forces, appear as yet inconceivably great; and there seems little probability of our being able to detect in them all any sameness, combined with the other distinguishing circumstances, as we have done in the case of gravity. Yet we should not despair. Boscovich has shown, in the most unexceptionable manner, that although we shall suppose that every atom of matter is endowed with a perfectly similar force, acting in a certain determined ratio of the small and imperceptible distances at which the particles of matter are arranged with respect to each other, the external or sensible appearances may, and must, have all that variety which we observe. He also shows very distinctly how, from the operation of this force, must arise some of the most general and important phenomena which characterize the different forms of tangible bodies.

We observe the chief varieties of the action of this corpuscular force upon the bodies which we denominate hard, soft, solid, fluid, vaporous, brittle, ductile, elastic. We see instances where the parts of bodies avoid each other, and require external force to keep them together, or at certain small distances from each other. This is familiar in air, vapours, and all compressible and elastic bodies, and is evidently a most curious and interesting subject of investigation. On the nature and action of these corpuscular forces depend the strength or firmness of solids, their elasticity, their power of communicating motion, the pressure, and motion, and impulse of fluids; nay, on the same actions depend all the chemical and physiological phenomena of expansion, fusion, congelation, vaporisation, condensation, solution, precipitation, absorption, secretion, fermentation, and animal and vegetable concoction and assimilation. Out of this immense store of phenomena, this inexhaustible fund of employment for our powers of investigation, the natural philosopher selects those which lead directly to the production or modification of sensible motion.

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He will therefore consider, firstly, the communication of motion amongst detached and free bodies, establishing the laws of impulse or collision. This has always been considered as the elementary doctrine of mechanical philosophy, and as the most familiar fact observed in the material world; and in all ages philosophers have been anxious to reduce all actions of bodies upon each other to impulse, and have never thought a phenomenon completely explained or accounted for until it had been shown to be a case of impulse. This it is which has given rise to the hypotheses of vortices, ethers, magnetic and electric fluids, animal spirits, and a multitude of fancied intermediums between the sensible masses of matter, which are said in common language to act upon each other. A heavy body is supposed to fall, because it is impelled by a stream of an invisible fluid moving according to certain conditions suited to the case. The filings of iron are supposed to be arranged round a magnet by means of a stream of magnetic fluid issuing from one pole, circulating perpetually round the magnet, and entering at the other pole, in the same manner as we observe the flote-grass arranged by the current of a brook.

But the philosopher who has commenced the mechanical study of nature by the abstract doctrines of dynamics, and made its first application to the celestial phenomena, and who has attended carefully to the many analogies between the phenomena of gravitation and cohesion, will be at least ready to entertain very different notions of this matter. He will be so far from thinking that the production of motion by impulse is the most familiar fact in nature, that he will acknowledge it to be comparatively very rare; nay, there are some appearances in the facts, which are usually considered as instances of impulsion, which will lead him to doubt, and almost to deny, that there has *ever been observed* an instance of one body putting another in motion by coming into absolute contact with it, and striking it; and he will be disposed to think that the production of motion in this case is precisely similar to what we observe when we gently push one floating magnet towards another, with their similar poles fronting each other. There will be the same production of motion in the one and diminution of it in the other, and the same uniform motion of the common centre of gravity: and, in this case of the magnets, he sees completely the necessity of a law of motion, which is not an axiom, but is observed throughout the whole of nature, and which receives no explanation from any hypothesis of an intervening fluid, but is even totally inconsistent with such a supposition. We mean, "that every action of one body on another is accompanied by an equal and opposite action of that other on the first." This is usually called the *equality of action and re-action*. It is not intuitive, but it is universal; and it is a necessary consequence of the perfect similarity of the corpuscular forces of the same kinds of matter. This general fact, unaccountable on the hypothesis of impelling fluids, is considered in the planetary motions as the unequivocal indication of the sameness of that gravity which regulates them all. The rules of good reasoning should make us draw the same conclusion here, that the particles of tangible matter are connected by equal and mutual forces, which are the *immediate causes* of all their sensible actions, and that these forces, like gravitation, vary with every change of distance and situation.

Of motion
as it respects the
theory of
machines,
&c.

The laws of collision and impulsion being now established, either as original facts, or as consequences of the agency of equal and mutual forces which connect the particles of matter, the philosopher considers, secondly, the production of motion by the intervention of solid bodies, where, by reason of the cohesion of matter, some of the motions are necessarily confined to certain determinate paths or directions. This is the case in all motions round fixed points or axes, or along planes or curves which are oblique to the action of the forces.

Mechanics.

This part of the study contains the theory of machines, pointing out the principles on which their energy depends, and consequently furnishing maxims for their construction and improvement. But these observations do not complete the discussion of the mechanism of solid bodies. They are not only solid and inert, but they are also heavy; and therefore the action of gravity must be combined with the consequences of solidity. This will lead to discussions about the centre of gravity, the theory and construction of arches and roofs, the principles of stability and equilibrium, the attitudes of animals, and many particulars of this kind.

The nature
and definition of fluidity.

Thirdly, the philosopher will now turn his attention to another form in which tangible matter exhibits many interesting phenomena, namely, *fluidity*. The first thing to be attended to here is, What is that particular form of existence? What is the precise phenomenon which characterizes fluidity? What is the definition of a fluid? This is by no means an easy question, and considerable objections may be stated against any definition that has been given of it. Sir Isaac Newton says, that a fluid is a body whose particles yield to the smallest impression, and by so yielding are easily moved amongst themselves. It may be doubted whether this be sufficiently precise; what is meant by the smallest impression? and what is easily moving? Is there any precise degree of impression to which they do not yield; and do they oppose any resistance to motion? And a still stronger objection may be made. It is not clear that a body so constituted will exhibit all the appearances which a body acknowledged to be fluid does really exhibit. Euler offers some very plausible reasons for doubting whether it will account for the horizontal surface, and the complete propagation of pressure through the fluid in every direction; and therefore prefers selecting this last phenomenon, the propagation of pressure *quaqua versum*, as the characteristic of fluidity, because a body having this constitution (on whatever circumstance it may depend) will have every other observed property of a fluid. But this definition is hardly simple or perspicuous enough; and we think that the objections against Newton's more simple and intelligible definition are not unanswerable. Boscovich defines a fluid to be *a body whose particles exert the same mutual forces in all directions*, and shows that such particles must be indifferent, as to any position, with respect to each other. If no external force act upon them, they will remain in every position, and will have no tendency to arrange themselves in one position rather than another; differing in this respect from the particles of solid, or soft, or viscid bodies, which require some force to change their respective positions, and which recover these positions again when but gently disturbed. He illustrates this distinction very beautifully, by comparing a parcel of balls thrown on quicksilver, and attracting each other, with a parcel of magnets in the same situation. The balls will stick together, but in *any position*; whereas the magnets will always affect a particular arrangement.

When the characteristic phenomenon of fluidity has been selected, the philosopher proceeds to combine this property with gravity, and establishes the doctrine of hydrostatics, or of the pressure and equilibrium of heavy fluids, the propagation of this pressure in every direction; and demonstrates the horizontality of surface assumed by all perfect fluids. These doctrines and principles enable us to determine several very interesting circumstances respecting the mutual pressure of solids and fluids on each other, such as the pressures exerted on the bottoms and sides of vessels, and the support and whole mechanism of floating bodies.

Of the pressure and equilibrium of fluids, or hydrostatics.

Of the motion of fluids, or hydraulics.

He then considers how fluids will move when their equilibrium of pressure is destroyed; and establishes the doctrines of hydraulics, containing all the modifications of this motion, arising from the form of the vessels, or from the intensity or direction of the pressure which occasions it. And this subject is completed by the consideration of the resistance which fluids oppose to the motion of solid bodies through them, and their impulse on bodies opposed to their action. These are very important matters, being the foundations of many mechanical arts, and furnishing us with some of our most convenient and efficacious powers for impelling machines. They are also of very difficult discussion, and have by no means been completely investigated or established. Much remains yet to be done, both for perfecting the theories, and for improving the arts which depend upon them.

Importance of these branches of science.

It is evident that upon these doctrines depend the knowledge of the motions of rivers and of waves; the buoyancy, equilibrium, and stability of ships; the motion of ships through the waters; the action of the winds on the sails; and the whole arts of marine construction and seamanship.

The nature and definition of vapour.

There is another general form of tangible matter which exhibits very different phenomena, which are also extremely interesting; we mean that of vapour. A vapour is a fluid, and all the vapours that we know are heavy fluids; they are therefore subject to all the laws of pressure and impulse. But they are susceptible of great compression by the action of external forces, and expand again when these forces are removed. In consequence of this compression and expansion, the general phenomena of fluidity receive great and important modifications; and this class of fluids requires a particular consideration. As air is a familiar instance, this branch of mechanical philosophy has been called pneumatics.

The doctrine of air, or pneumatics.

Under this head we consider the pressure of the atmosphere, and its effects both on solid and on fluid bodies. It produces the rise of waters or other fluids in pumps and syphons, and gives us the theory of their construction. It explains many curious phenomena of nature, such as the motions in the atmosphere, and their connection with the pressure of the air, and its effect upon the barometer or weather-glass. Air, when in motion, is called *wind;* and it may be employed to impel bodies. The theory of its action, and of its resistance to moving bodies, is therefore to be considered in this place.

But besides their motions of progression, &c. such as we observe in winds, compressible or elastic fluids are susceptible of what may be termed internal motion; a kind of undulation, where the contiguous parts are thrown into tremulous vibrations, in which they are alternately condensed and rarefied; and these undulations are propagated along the mass of elastic fluid, much in the same way in which we observe waves to spread on the surface of water. What makes this an interesting subject of consideration is, that these undulations are the more ordinary causes of sound. A trembling chord, or spring, or bell, agitates the air adjoining to it. These agitations are propagated along the air, and by its intervention agitate the organ of hearing. The mechanism of these undulations has been much studied, and furnishes a very beautiful theory of musical harmony.

Of the pressi of elas fluids.

The philosopher examines the *law of compressibility* of air and other elastic fluids, and thus gets the knowledge of the constitution of the atmosphere, and of the action of those fluids when employed to impel solid bodies. Gunpowder contains an immense quantity of permanently elastic air, which may be set at liberty by inflammation. When this is done at the bottom of a piece of ordnance, it will impel a ball along the barrel, and discharge it from the muzzle, in the same way that an arrow is impelled by a bow. And thus having discovered in what degree this air presses in proportion to its expansion, we discover its action on the ball throughout the whole length of the piece, and the velocity which it will finally communicate to the ball. Here then is contained a theory of artillery and of mines.

Of the versio bodie elastic by fir

Chemistry teaches us, that most bodies can be converted by fire into elastic fluids, which can be employed to act upon other bodies in the way of pressure or impulse. Thus they come under the review of the mechanical philosopher; and they have become interesting by being employed as moving forces in some very powerful machines.

These discussions will nearly exhaust all the general mechanical phenomena. There remain some, however, which are much more limited, but furnish very curious and important subjects of investigation.

Of the nome loads or ma tism.

The phenomena exhibited between loadstones or magnets and iron have long attracted attention; and the use to which the polarity of the loadstone has been applied, namely, the directing the course of a ship through the pathless ocean, has rendered these phenomena extremely interesting. They are specified by the term magnetism. Considerable progress has been made in the arrangement and generalization of them; but we have by no means been able hitherto to bring them all under one simple fact or law. The attention has been too much turned to the discovery of the ultimate cause of magnetism; whereas we should have rather employed our ingenuity in discovering all the general laws, in the same manner as Kepler and Newton did with respect to the celestial phenomena, without troubling themselves with the cause of gravitation. Dr Gilbert of Colchester was the first who considered the magnetical phenomena in a truly philosophical manner; and his treatise *De Magnete* may be considered as the first, and one of the most perfect specimens of inductive logic. It is indeed an excellent performance; and when we consider its date, 1580, it is almost a wonder. Æpinus's *Tentamen Theoriæ Magnetismi* is a most valuable work, and contains nearly all the knowledge which we have as yet of the subject.

Of el cal pl mena.

There is another class of mechanical phenomena which have a considerable affinity with the magnetical; we mean the phenomena called electrical. Certain bodies, when rubbed or otherwise treated, attract and repel other bodies, and occasion a great variety of sensible motions in the neighbouring bodies. Philosophers have of late years paid much attention to these appearances, and have established many general laws concerning them. But we have not been more successful in bringing them all under one fact or law, and thus establishing a complete theory of them, than in the case of magnetism. Franklin and Æpinus are the authors who have been most successful in this respect. Dr Franklin, in particular, has acquired great celebrity by his most sagacious comparison of the phenomena; which has enabled him to establish a few general laws, almost as precise as those of Kepler, and of equally extensive influence. His discovery, too, of the identity of thunder and electricity has given an importance and dignity to the whole subject. There are many phenomena of electricity which cannot be called mechanical, and are of the most curious and interesting kind. As these have little connection with any of the other great branches of physical science, they have generally been considered in treatises of natural philosophy; and, along with inquiries into the original cause of electricity in general, continue to engage much of our attention.

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The appearances which are presented to us by our sense of seeing form another class, which has always been considered as forming a branch of natural philosophy in all seminaries of learning. It does not, however, obviously appear that they are mechanical phenomena. The intimate nature of light is still a secret. Fortunately it is not necessary to be known to give us a very perfect theory of the chief phenomena. The general laws of optics are so few, so simple, and so precise, that our theories are perhaps more perfect here than in any other branch of physics; but these theories are as yet far removed from the rank of primary facts. Many unknown events happen before the phenomenon comes under the hands of the ordinary optician, so as to become the subjects of the simple laws of reflection and refraction. It may even be doubted, and has been doubted, whether the phenomena of optics are cases of body in motion; whether all the lines which the optician draws are any thing but the directions along which certain qualities are exerted. The side of a ball which is next the candle may be bright and the other side dark, just as the side of a ball which is next the electrical globe is *minus* and the other side *plus*; and all this without any intervening medium. Apparition or visibility may be a quality of a body, depending on the proximity and position of another body, without any thing between them, just as weight is; and this quality may be cognizable by our faculty of seeing alone, just as the pressure of a heavy body is by our feeling alone.

optics to be ered art of nical ophy.

The first thing which made it probable that mechanical philosophy had any thing to do with the phenomena of optics, was the discovery of Mr Roemer, "that apparition was not instantaneous;" that some time elapsed between the illumination of a body and its being seen at a distance. He discovered that it was not till forty minutes after the sun illuminated one of Jupiter's satellites that it was seen by the inhabitants of this globe. If therefore a sun were just created, it would be forty minutes before Jupiter would be illuminated by him, and two hundred before the Georgian planet would be illuminated. Here then is motion. It is therefore highly probable that there is something moved; but it is still doubted whether this something, which we call *light*, is a matter emitted from the shining body, and moving with great velocity, and acting upon and affected by other bodies in the various phenomena of optics, or whether it is a certain state of a medium which is thus propagated, as we see that waves are propagated along the surface of water, or sonorous undulations through the mass of air, whilst the water or air itself is hardly moved out of its place. Either of these suppositions makes optics a legitimate branch of mechanical philosophy; and it is the philosopher's business to examine both by the received laws of motion, and to see which of them gives consequences which tally with the phenomena. This has been done; and we imagine that a complete incompatibility has been demonstrated between the consequences of the undulations of an elastic medium and the phenomena of optics, whilst the consequences of the other or vulgar notion on this subject are perfectly consistent with mechanical laws. There are some things in this hypothesis very far beyond our power to conceive distinctly; but they are all similar in this respect to many facts acknowledged by all, and there is no phenomenon that is inconsistent with the legitimate consequences of the hypothesis. This gives it great probability; and this probability is confirmed by many chemical facts, and by facts in the vegetable economy, which give strong and almost undeniable indications of light being a body capable of a chemical union with the other ingredients of sublunary bodies, and of being afterwards set at liberty under its own form, as the cause or medium of vision. But these are questions similar to those about the cause of gravity, and totally unnecessary for establishing a complete theory of the optical phenomena for explaining the nature of vision, the effects of optical instruments, the cause of colours, the phenomena of the rainbow, halos and parhelia, &c. Only all this theory is unconnected with the principles called mechanical.

The probable increase of this extensive field of observation.

Such is the field of observation laid open to the mechanical philosopher of the present day. We may hope to extend it, and by degrees apply its doctrines even to the unseen motions which take place in chemistry and physiology. But we must, in the first place, perfect our knowledge and description of the sensible motions and actions of bodies. Those of fluids still demand much investigation; and till these are thoroughly understood, it is not time to attempt penetrating further into the recesses of nature.

Investigation of the law that action is always equal and opposite to re-action.

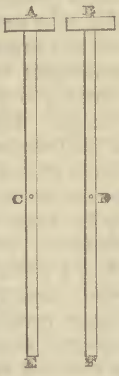
In the prosecution of this study, it is found that every change which can be observed in the state of a body, with respect to motion by the action of another body, is accompanied by an equal and opposite change in the state of that other body. Thus, in the phenomena of gravitation, it is observed that the deflections of the sun and planets are mutual. The same thing is observed in the actions of magnets on each other and on iron; it is also observed in the attractions and repulsions of electrical bodies; and it also obtains in all the phenomena of impulse and of corporeal pressure. It is therefore an universal law of motion, that *action is always equal and opposite to re-action;* but this must be considered merely as a matter of fact, a contingent law of nature, like that of gravitation. The contrary is perfectly conceivable, and involves no contradiction. That this is so, is evident from the proceedings of philosophers, who in every new case make it their business to discover by experiment whether this law was observed or not. It was amongst the last discoveries made by Sir Isaac Newton in his examination of the celestial motions. This being the case, it should never be assumed as a principle of reasoning until its operation has been ascertained by observation. It has been owing to this improper procedure that much false reasoning has been introduced into mechanical philosophy, and more particularly into the theory of impulsion, or the communication of motion by impulse. In considering this subject, a term has been introduced which has occasioned much wrangling and misconception; we mean the term *inertia*. It serves indeed to abbreviate language, but it has often misled the judgment. When used with cautious attention to every circumstance, it expresses nothing but the necessity of a cause to the production of any effect; but it is generally used as expressing a quality inherent in matter, by which it *resists* any change of state, or by which it maintains its present state. Matter is said to be inert; and as everything which changes the motion of a body is called a *force*, and as the inertia of A is supposed to change the motion of B, it is called *vis inertiæ;* and yet matter is said to be indifferent as to motion or rest, and to be inactive. These are surely very incongruous expressions. This obscure discourse has arisen from the poverty of all languages, which are deficient in original terms, and therefore employ figurative ones. Force, action, resistance, are all appropriated terms relating to our own exertions; and some resemblance between the external effects of these exertions and the effects of the connecting qualities of natural bodies, has made us use them in our disquisitions on these subjects. And as we are conscious that, in order to prevent our being pushed by another from our place, we must resist, exerting force; and that our resistance is the reason why this other man has not accomplished his purpose; we say, that the quiescent body resists being put in motion, and that its inertia is discovered by the diminution made in the motion of the impelling body. And upon the authority of this *vis inertiæ* as a first principle the phenomena of impulsion are explained, and the law of equal action and re-action is established.

But all this procedure is in contradiction to the rules of inductive logic; and the obscurity and confusion which have arisen from this original misconception, the consequent incongruity of language, and the awkward attempts that have been made to botch and accommodate it to the real state of things, have occasioned a dispute, and the only dispute, in natural philosophy, which has not yet been settled, and never can be settled, whilst such misconceptions are allowed to remain.

Proper meaning of the term *inertia.*

If the word *inertia* be taken as expressing, not a quality of matter, but a law of human judgment respecting matter, as expressing our necessity of inferring the agency of a moving force whenever we observe a change of motion, all difficulties will vanish, and the equality of action and re-action will be inferred, as it should be, from the phenomena of collision. There will be inferred a *vis insita corpori impellenti*, not *qua moventi*, but *qua corpori;* and this inference will carry us through all the mysteries of corporeal action, as it conducted Sir Isaac Newton in his grand researches.

Let us just consider how we reason in a new case. Let A and B be two magnets fastened on the ends of two long wooden laths AE, BF, which turn horizontally on pivots C, D, like compass needles, with their north poles fronting each other, twelve inches apart; and let A be pushed towards B, so that it would move uniformly with the velocity of two inches in a second. The phenomena *which have been observed* are as follow: A will gradually diminish its velocity; and when it has advanced about nine inches, will stop completely. B in the mean time will gradually acquire motion; and when it has advanced about nine inches, will have a velocity of about two inches per second, with which it will continue to move uniformly. Now, what is inferred from these phenomena? Because the motion of A is gradually retarded, we infer that a retarding force, that is, a force in the direction BA, has acted on it. And since this would not have happened if B had not been there, and always happens when B is there, we infer that B is either its cause or the occasion of its action. The vulgar say that B repels A; and so also say the dynamists. The abettors of invisible fluids say that a stream of fluid issuing from B impels A in the opposite direction. All naturalists agree in saying, that an active force connected with B has destroyed the motion of A, and consider this curious phenomenon as the indication and characteristic of a discovery. The same inference is made from the motion produced in B; it is considered by all as effected by a force exerted or occasioned by the presence of A; wherefore the dynamists and the vulgar say that A *repels* B. And both parties conclude, from the equal changes made on both bodies, that the changing forces are equal; here acknowledging that they *observe* an equality of action and re-action; and they add this to the other instances of the extent of this law of motion. All this while no one thinks of the inertia or inactivity of B, but, on the contrary, conclude this to be a curious instance of its activity, and most people conclude that both bodies carry about with them a *vis insita* both when at rest and when in motion.



Doubtful whether actual contact has ever been observed.

If other phenomena give unquestionable evidence that in ordinary collisions there is the same changes of motion, produced without mathematical contact, the same inferences must be drawn; and a scrupulous naturalist will doubt whether contact should make any change in our reasonings on the subject, and whether actual contact ever has been or can be observed. He will also be convinced, that whilst this is the general, or perhaps universal, process of nature in producing motion by impulse, all explanations of the action of bodies *e distanti*, by the intervention of ethers and other invisible fluids, are nothing but multiplying the difficulties; for instead of one fact, the approach of one magnet, for instance, to another, they substitute millions of unseen impulses, each of which equally needs an explanation. And if this fluid be supposed to produce its effects by any *peculiarity* in its constitution, as in the case of Newton's elastic ether, proposed by him to explain gravitation, the hypothesis substitutes, in the most unqualified manner, millions of similar phenomena for the one to be explained; for there is the same want of a second fluid in order to produce that mutual recess of the particles of the ether which constitutes its elasticity.

And this seems to be the limit to our inquiries into all the classes of natural phenomena. We find the masses or the particles of matter endued, in fact, with qualities which affect the state of other particles or masses, at smaller or at greater distances from each other, according to certain general rules or laws. This ultimate step in the constitution of things is inscrutable by us. It is arrogance in the highest degree for us to say, that because we do not comprehend how there is inherent in a body any quality by which another body may be affected at any distance from it, therefore no such quality *is possible*. It is no less so to say, that matter has no active property but that of moving other matter by impulse; and that because it may be so moved, and also by the agency of our own minds, therefore, when it is not moved by impulse, it is moved by minds. The same almighty FIAT which brought a particle of matter into existence could bring those qualities equally into existence; and the *how* in both is equally beyond our comprehension.

But, on the other hand, we must carefully guard against the incurious resting on this consideration, as a stop to further inquiry. There may be species of matter possessed of the mechanical powers, and which notwithstanding is not cognisable by our senses. All the properties of matter are not known to a person who is both deaf and blind; and beings possessed of more senses may perceive matter where we do not; and many phenomena may really be produced by the action of intervening matter, which we, from indolence or from haste, ascribe to the agency of inherent forces. The industry of philosophers has already discovered *intermedia* in some cases. It is now certain that air is the conductor of sound, and it is almost certain that there is such a thing as light. Let us therefore indulge conjectures of this kind, and examine the conjectures by the received laws of motion, and reject them when we find the smallest inconsistency; and always keep in mind, that even the most coincident with the phenomena is still but a possibility.

We may conclude the whole of these observations with the remark, that the questions about the activity or inactivity of matter are not *physical*, but *metaphysical.* Natural philosophy, it is true, commonly takes it for granted that matter is wholly inactive; but it is not of any moment in physics whether this opinion be true or false. Whether matter be acted on according to certain laws, or whether it act of itself according to the same laws, makes no difference to the natural philosopher. It is his business to discover the laws which really obtain, and to apply these to the solution of subordinate phenomena; but whether these laws arise from the nature of some agent external to matter, or whether matter itself is the agent, are questions which may be above his comprehension, and do not immediately concern his proper business.

The account we have now given of natural philosophy points out to us in the plainest manner the way in which the study must be prosecuted, and the helps which must be taken from other branches of human knowledge. The causes, powers, forces, or by whatever name we choose to express them, which produce the mechanical phenomena of the universe, are not observed, and are known to us only in the phenomena themselves. Our knowledge of the mechanical powers of nature must therefore keep pace with our knowledge of the motions, and indeed is nothing different from it. In order to discover and determine the forces by which the moon is retained in her orbit round the earth, we must know her motions. To a terrestrial spectator she appears to describe an ellipse, having the earth in one focus; but, in the mean time, the earth is carried round the sun, and the moon's real path, in absolute space, is a much more complicated figure. Till we know this figure, and the variations in the velocity with which it is described, we know nothing of the forces which actuate the moon in her orbit.

When Newton says that the forces by which she is retained in this elliptical orbit are directed to the earth, what does he mean? Only this, that the deflections from that uniform rectilineal motion which she would otherwise have performed are always in this direction. In like manner, when he says that these forces are inversely proportional to the squares of her distances from the earth, he only means that the deflections made in equal times in different parts of her motion are in this proportion. These deflections are considered as the characteristics and measures of the forces. We imagine that we have made all plain when we call this indicated cause a *tendency* to the earth; but we have no notion of this tendency to the earth different from the approach itself. This word tendency, so fashionable amongst the followers of Sir Isaac Newton, is perverted from its pure and original sense. *Tendere versus solem*, is, in the language of Rome, and also of Newton, to go towards the sun; but we now use the words tend, tendency, to signify, not the approach, but the *cause* of this approach; and when called upon to speak still plainer, we desert the safe paths of plain language, and express ourselves by metaphor, speaking of *nisus, conatus, vis centripeta*, and the like. When these expressions have become familiar, the original sense of the word is forgotten, and we take it for granted that the words never had another meaning; and this metaphor, sprung from the poverty of language, becomes a fruitful source of misconception and mistake. The only way to secure ourselves against such mystical notions as are introduced by these means into philosophy, is to have recourse to the way in which we acquire the knowledge of these fancied powers; and then we see that their names are only names for phenomena, and that universal gravitation is only an universal mutual approach amongst the parts of the solar system.

There is one case in which we fondly imagine that we know the cause independently of the effect, and that we could have predicted the phenomenon *a priori;* we mean the case of impulse: and hence it is that we are so prone to reduce everything to cases of impulsion, and that we have fallen upon all those subterfuges of ethers and other subtile fluids. But we might have saved ourselves all this trouble; for after having, by much false reasoning and gratuitous assumptions, shown that the phenomenon in question *might have been produced* by impulse, we are no nearer our purpose, because that property by which matter in motion puts other matter in motion, is known to us only by and in the effect. The fair and logical deduction from all this is, that we must not expect any knowledge of the powers of nature, the immediate causes of the motions of bodies, but by means of a knowledge of the motions themselves; and that every mistake in the motions is accompanied by a similar mistake in the causes. It is impossible to demonstrate or explain the gravitation of the planets to him who is ignorant of the properties of the ellipse, or the theory of gunnery to him who does not know the parabola.

A man cannot be a good natural philosopher without being a mathematician.

A notion has been sometimes advanced, that a man may become a natural philosopher without mathematical knowledge; but this is entertained by none who have any mathematics themselves; and surely those who are ignorant of mathematics should not be sustained as judges in this matter. We need only appeal to fact. It is only in those parts of natural philosophy which have been mathematically treated, that the investigations have been carried on with certainty, success, and utility. Without this guide, we must expect nothing but a school-boy's knowledge, resembling that of the man who takes up his religious creed on the authority of his priest, and can neither give a reason for what he imagines that he believes, nor apply it with confidence to any valuable purpose in life. These observations, on the other hand, show us the nature of the knowledge which may be acquired, and the rank which natural philosophy holds among the sciences.

The motions of bodies are subjects of pure mathematical disquisition.

Motions are the real and only objects of our observation, the only subjects of our discussion. In motion are included no ideas but those of space and time, the subjects of pure mathematical disquisition. As soon, therefore, as we have discovered the fact, the motion, all our future reasonings about this motion are purely mathematical, depending only on the affections of figure, number, and proportion, and must carry along with them that demonstration and irresistible evidence which is the boast of the science. To this we are indebted for that accuracy which is attained, and the progress which has been made, in some branches of mechanical philosophy; for when the motions are distinctly and minutely understood, and then considered only as mathematical quantities, independently of all physical considerations, and we proceed according to the just rules of mathematical reasoning, we need not fear any intricacy of combination or multiplicity of steps; we are certain that truth will accompany us, even though we do not always attend to it, and will emerge in our final proposition, in the same manner as we see happen in a long and intricate algebraic analysis.

Mechanical philosophy is almost wholly a mathematical study.

It appears from what has been said, that mechanical philosophy is almost wholly a mathematical study, and that it is to be successfully prosecuted only under this form; but in our endeavours to initiate the young beginner, it will be often found to require more steadiness of thought than can generally be expected for keeping the mind engaged in such abstract speculations. The object presented to the mind is not readily apprehended with that vivacity which is necessary for enabling us to reason upon it with clearness and steadiness, and it would be very desirable to have some means of rendering the conception more easy, and the attention more lively. This may be done by exhibiting to the eye an experiment, which, though but a single fact, gives us a sensible object of perception, which we can contemplate and remember with much more steadiness than any mere creature of the imagination. We could, by an accurate description, give such a conception of a room that the hearer should perfectly comprehend our narration of any occurrence in it; but one moment's glance at the room would be infinitely better. It is usual therefore to employ experiments to assist the imagination of the beginner; and most courses of natural philosophy are accompanied by a series of such experiments. Such experiments, connected by a slight train of argumentative discourse, may even serve to give a notion of the general doctrines, sufficient for an elegant amusement, and even tending to excite curiosity, and engage in a serious prosecution of the study. Such are the usual courses which go by the name of *Experimental Philosophy.* But this is a great misapplication of the term; such courses are little more than *illustrations* of known doctrines by experiments.

Experimental philosophy defined and explained.

EXPERIMENTAL PHILOSOPHY is the investigation of general laws, as yet unknown, by experiment; and this is the most infallible, and indeed the sole, way of arriving at the knowledge of them. This is the *Novum Organum Scientiarum* strongly recommended by Lord Bacon. It was new in his time, though not altogether without example; for it is the procedure of nature, and is followed whenever curiosity is excited. There was even extant in his time, as we have already mentioned, a very beautiful example of this method, namely, the Treatise of the Loadstone, by Dr Gilbert of Colchester; a work which has hardly been excelled by any, and which, when we consider its date, about the year 1580, is really a most wonderful performance. The most perfect model of this method is the Optics of Sir Isaac Newton. Dr Black's Essay on Magnesia is another very perfect example; and Dr Franklin's Theory of Electricity is a third example of great merit. That the investigation is not complete, nor the conclusions certain, is not an objection. The method is without fault; and a proper direction is given to the mind for the experiments which are still necessary for establishing the general laws.

A good treatise on the method of inquiry by experiment very necessary.

It were much to be wished that some person of talents and of extensive knowledge would give a treatise on the method of inquiry by experiment. Although many beautiful and successful examples have been given as particular branches of inquiry, we have but too many instances of very inaccurate and inconclusive investigations. Experiments made at random, almost without a view, serve but little to advance our knowledge. They are like shapeless lumps of stone merely detached from the rock, but still wanting the skill of the builder to select them for the different purposes which they may chance to serve; whilst well-contrived experiments are blocks cut out by a skilful workman, according as the quarry could furnish them, and of forms suited to certain determined uses in the future edifice. Every little series of experiments by Margraaf terminates in a general law, whilst hardly any general conclusion can be drawn from the numberless experiments of Pott. Lord Bacon has written much on this subject, and with great judgment and acuteness of distinction; but he has exceeded in this, and has fatigued his readers by his numerous rules; and there is in all his philosophical works, and particularly in this, a quaintness and affectation which greatly obscure his meaning, so that this most valuable part of his writings is very little read.

An objection to experimental inquiry.

A formidable objection has been made to this method of inquiry. Since a physical law is only the expression of a general fact, and is established only in consequence of our having observed a similarity in a great number of particular facts; and since the great rule of inductive logic is to give the law no greater extent than the induction on which it is founded; how comes it that a few experiments must be received as the foundation of a general inference? This has been answered in very general terms in the article PHILOSOPHY. But it will be of use to consider the subject a little more particularly. Our observations on this subject are taken from the dissertation on evidence by Dr Campbell in his Philosophy of Rhetoric.

This objection answered.

An attentive consideration of the objects around us will inform us that they are generally of a complicated nature, not only as consisting of a complication of those qualities of things called accidents, such as gravity, mobility, colour, figure, solidity, which are common to all bodies; but also as consisting of a mixture of a variety of substances, very different in their nature and properties; and each of these is perhaps compounded of ingredients more simple. Moreover, the farther we advance in the knowledge of nature, we find the more reason to be convinced of her constancy in all her operations. Like causes have always produced like effects, and like effects have always been preceded by like causes. Inconstancy sometimes appears in nature's works at *first sight;* but a more refined experience shows us that this is but an appearance, and that there is no inconstancy; and we explain it to our satisfaction in this way.

Most of the objects being of a complicated nature, we find, upon an accurate scrutiny, that the effects ascribed to them ought often to be solely ascribed to one or more of these component parts, whilst the others either do not contribute to them, or hinder their production; and the variety of nature is so great, that hardly any two individuals of the same species are in every respect like any other. On all these accounts we expect dissimilitudes in the phenomena accompanying perfectly similar treatment of different subjects of the same kind; but we find, that whenever we can be assured that the two substances are perfectly alike, the phenomena arising from similar treatment are the same; and long and extensive observation teaches us, that there are certain circumstances which insure us in the perfect similarity of constitution of some things. Whenever we observe the effect of any natural agent on one, and but one, of these, we invariably expect that the same will be produced on any other.

Should a botanist meet with a plant new to him, and observe that it has seven monopetalous flowers, he will conclude with the utmost confidence that every plant of this species will have monopetalous flowers; but he will not suppose that it will have seven, and no more than seven, flowers. Now these two facts seem to have no difference to warrant such a difference in the conclusion; which may therefore seem capricious, since there is but one example of both. But it is not from this example only that he draws the conclusion. Had he never before taken notice of any plant, he would not have reasoned at all from these remarks. But his mind runs immediately from this unknown species to all the known species of this genus, and to all the genera of the same order; and having experienced in the *figure* of the flower an uniformity in every species, genus, and order, which admits of no exception, but, in the *number* of flowers, a variety as boundless as are the circumstances of soil, climate, age, and culture, he learns to mark the difference, and draws the above-mentioned conclusions. Thus we learn, that *perfect* uniformity is not to be expected in any instance whatever, because in no instance is the simplicity of constitution sufficiently great to give us assurance of perfect uniformity in the circumstances of the case; and the utmost that our experience can teach us is a quick discrimination of those circumstances which produce the occasional varieties.

The nearer that our investigations carry us to the knowledge of elementary natures, the more are we convinced by general experience of the uniformity of the operations of real elements; and although it may perhaps be impossible for us ever to arrive at the knowledge of the simplest elements of any body, yet when any thing appears simple, or rather so exactly uniform, as that we have invariably observed it to produce similar effects, on discovering any *new* effect of this substance, we conclude, from a general experience of the efficient, a little constancy in the energy as to the rest. Fire consumes wood, melts lead, and hardens clay. In these instances it acts uniformly, but not in these only. We have always found, that whatever of any species is consumed by it in one instance, has been consumed by it upon trial at any time. If therefore a trial be made for the first time of its influence on any particular substance, he who makes it is warranted to conclude that the effect, whatever it may be, is a faithful representative of its effects on this substance in all past and future ages. This conclusion is not founded on this single instance, but upon this instance combined with the general experience of the regularity of this element in its operations.

This general conclusion, therefore, drawn from one experiment, is by no means in opposition to the great rule of inductive logic, but, on the contrary, it is the most general and refined application of it. General laws are here the real subject of consideration; and a law still more general, *that nature is constant in all its operations*, is the inference which is here applied as a principle of explanation of a phenomenon which is itself a general law, viz. *that nature is constant in this operation.*

The foundation of this general inference from one experiment being so firmly established, it is evident that experiments must be an infallible method of attaining to the knowledge of nature; and we need only be solicitous that we proceed in a way agreeable to the great rule of inductive logic; that is, the subject must be cleared of every accidental and *unknown* circumstance, and put into a situation that will reduce the interesting circumstance to a state of the greatest possible simplicity. Thus we may be certain that the event will be a faithful representative of every similar case; and unless this be done in the preparation, nothing can result from the most numerous experiments but uncertainty and mistakes.

The account which has been given of mechanical philosophy would seem to indicate that experiment was not of much use in the farther prosecution of it. The two laws of motion, with the assistance of mathematics, seem fully adequate to the explanation of every phenomenon; and so they are to a certain degree. But this degree is as yet very limited. Our mathematical knowledge, great as it is in comparison with that of former times, is still insufficient for giving accurate solutions even of questions, comparatively speaking, very simple. We can tell, with the utmost precision, what will be the motions of two particles of matter, or two bodies, which act on each other with forces proportioned to the squares of the distances inversely; but if we add a third particle, or a third body, acting by the same law, the united science of all Europe can only give an approximation to the solution.

What is to be done, then, in the cases which come continually before us, where millions of particles are acting at once upon each other in every variety of situation and distance? How shall we determine, for instance, the motion of water through a pipe or sluice when urged by a piston or by its own weight? what will be its velocity and direction? It is impossible, in the present state of mathematical knowledge, to tell with any precision or certainty. And here we must have recourse to experiment. But if this be the case, must the experiment be made in every possible variety of situation, depth, figure, pressure? or is it possible to find out any general rules, founded on the general laws of motion, and rationally deduced from them? Or, if this cannot be accomplished, will experiment itself furnish any general coincidences which show such mutual dependences, that we may consider them as indications of general principles, though subordinate, complicated, and perhaps inscrutable? This can be discovered by experiment alone.

The attention of philosophers has been directed to each of these three chances, and very considerable progress has been made in them all. Numerous experiments have been made, and are almost sufficient to direct the practice in many important cases, without the help of any rule or principle whatever. But there are many cases, and these of by far the greatest importance, such as the motion of a ship impelled by the winds, resisted by the water, and tossed by the waves, where distinct experiments cannot be made.

Newton, Bernoulli, D'Alembert, and others, have laboured hard to deduce from the laws of motion rules for determining what may be called the average motion of water in these circumstances, without attempting to define the path or motion of any individual particle; and they have actually deduced many rules which have a great degree of probability. It may here be asked, Why do you say *probability?* The rules, as far as they go, should be *certain.* So they are; they are strict deductions from their premises. But the premises are only *suppositions,* of various degrees of probability, assumed in order to simplify the circumstances of the case, and to give room for mathematical reasoning; therefore these deductions, these rules, must be examined by experiment. Some of the suppositions are such as can hardly be refused, and the rules deduced from them are found to tally precisely with the phenomena. Such is this, that the velocities of issuing water in similar circumstances are in the subduplicate ratio of the pressures. And this rule gives most important and extensive information to the engineer. Other suppositions are more gratuitous, and the rules deduced from them are less coincident with the phenomena. The patient and sagacious Newton has repeatedly failed in his attempts to determine what is the absolute velocity of water issuing from a hole in the bottom of the vessel when urged by its weight alone, and the attempts of the others have hardly succeeded better. Experiment is therefore absolutely necessary on this head.

Example of the necessity of experiment.

Those who have aimed at the discovery of rules purely experimental on this subject, have also been pretty successful; and the Chevalier de Buat has, from a comparison of an immense variety of experiments made by himself and various others, deduced an empirical rule, which will not be found to deviate from truth above one part in ten in any case which has yet come to our knowledge.

This instance may serve to show the use of experiments in mechanical philosophy. It is highly proper in all cases by way of illustration; and it is absolutely necessary in most, either as the foundation of a characteristic of a particular class of phenomena, or as argument in support of a particular doctrine. Hydrostatics, hydraulics, pneumatics, magnetism, electricity, and optics, can hardly be studied in any other way.

The advantages derived from the study of philosophy.

Having in the preceding paragraphs given a pretty full enumeration of the different subjects which are to be considered in the study of natural philosophy, it will not be necessary to spend much time in a detail of the advantages which may reasonably be expected from a successful prosecution of this study. It stands in no need of panegyric; its intimate connection with the arts gives it a sufficient recommendation to the attention of every person. It is the foundation of many arts, and it gives liberal assistance to all. Indebted to them for its origin and birth, it has ever retained its filial attachment, and repaid all their favours with the most partial affection.

To this science the navigator must have recourse for that astronomical knowledge which enables him to find his place in the trackless ocean; and although very small scraps of this knowledge are sufficient for the mere pilot, it is necessary that the study be prosecuted to the utmost by some persons, that the unlearned pilot may get that scanty pittance which must direct his routine. The few pages of tables of the sun's declination, which he uses every day to find his latitude, required the successive and united labours of all the astronomers of Europe to make them tolerably exact; and in order to ascertain his longitude with precision, it required all the genius of a Newton to detect the lunar irregularities, and to bring them within the power of the calculator; and, until this was done, the respective position of the different parts of the earth could not be ascertained. Vain would have been the attempt to do this by geodetical surveys, independently of astronomical observation. It is only from the most refined mechanics that we can hope for sure principles to direct us in the construction and management of a ship, the boast of human art, and the great means of union and communication between the different quarters of the globe.

A knowledge of mechanics not much inferior to this is necessary for enabling the architect to execute some of his greatest works, such as the erection of domes and arches, which depend on the nicest adjustment of equilibrium. Without this he cannot unite economy with strength, and his works must either be clumsy masses or flimsy shells. The effects of artillery cannot be understood or secured without the same knowledge. The whole employment of the engineer, civil or military, is a continual application of almost every branch of mechanical knowledge; and whilst the promises of a Smeaton, a Watt, a Belidor, may be confided in as if already performed, the numberless failures and disappointments in the most important and costly projects show us daily the ignorance of the pretending crowd of engineers.

The microscope, the steam-engine, the thunder-rod, are presents which the world has received from the natural philosopher; and although the compass and the telescope were the productions of chance, they would have been of little service had they not been studied and improved by Gilbert, Halley, and Dollond.

But it is not in the arts alone that the influence of natural philosophy is perceived; it lends its aid to every science, and in every study. It is often necessary to have recourse to the philosopher in disputes concerning property; and many examples might be given where great injustice has been the consequence of the ignorance of the judges. Knowledge of nature might have prevented many disgraceful condemnations for sorcery. The historian who is ignorant of natural philosophy easily admits the miraculous into his narrations, accompanies these with his reflections, draws consequences from them, and fills his pages with prodigies, fables, and absurdity.

It is almost needless to speak of the advantages which will accrue to the physician from this study. So close is the connection between it and medicine, that our language has given but one name to the naturalist and to the medical philosopher. Indeed the whole of his study is a close observation of the laws of material nature, in order to draw from them precepts to direct his practice in the noble art of healing. During the immaturity of general knowledge, whilst natural philosophy was the only study which had acquired any just pretension to certainty either in its principles or method of investigation, the physicians endeavoured to bring the objects of their study within its province, hoping by this means to get a more distinct view of it; and they endeavoured to explain the abstruse phenomena of the animal functions by reducing them all to motions, vibrations, collisions, impulses, hydrostatic and hydraulic pressures and actions, with which the mechanical philosophers were so ardently occupied at that time. But unfortunately their acquaintance with nature was then very limited, and they were but little habituated to the rules of just reasoning; and their attempts to explain the economy of animal life by the laws of mechanics did them but little service either for the knowledge of diseases or for that of the methods of cure. The mechanical theories of medicine, which had considerable reputation about the end of the seventeenth century, were many of them very ingenious, and had an imposing appearance of symmetry and connection; but they are now forgotten, having all been formed on the narrow supposition that matter was subject only to mechanical laws.

The discovery of error, however, diminishes the chance of again going wrong, especially when the cause of error has been discovered, and the means pointed out of detecting the mistakes; and the vital principle must combine its influence with, or operate upon, the properties of rude matter. It appears therefore evident that a knowledge of the mechanical laws of the material world is not only a convenient, but a necessary, accomplishment to the physician. We are fully justified in this opinion, by observing medical authors of the present day introducing into medicine theories borrowed from mechanical philosophy, which they do not understand, and which they continually misapply. Appearance of reasoning frequently conceals the errors in principle, and seldom fails to mislead.

But there is no class of men to whom this science is of more service than to those who hold the honourable office of the teachers of religion. Their knowledge in their own science, and their public utility, are prodigiously hurt by ignorance of the general frame and constitution of nature; and it is much to be lamented that this science is so generally neglected by them, or considered only as an elegant accomplishment. Nay, it is too frequently shunned as a dangerous attainment, as likely to unhinge their own faith, and taint the minds of their hearers. We hope, however, that few are either so feebly rooted in the belief of the great doctrines of religion as to fear this, or of minds so base and corrupted as to adopt and inculcate a belief which they have any suspicion of being ill founded. But many have a sort of horror at all attempts to account for the events of nature by the intervention of general causes, and think this procedure derogatory to the Divine nature, and inconsistent with the doctrine of his particular providence; believing that "a sparrow does not fall to the ground without the knowledge of our heavenly Father." Their limited conceptions cannot perceive, that, in forming the general law, the Great Artist did at one glance see it in its remotest and most minute consequence, and adjust the vast assemblage so as completely to answer every purpose of his providence. There never was a more eager inquirer into the laws of nature, or more ardent admirer of its glorious Author, than the Honourable Robert Boyle. This gentleman says, that he will always think more highly of the skill and power of that artist who should construct a machine, which, being once set a-going, would of itself continue its motion for ages, and from its inherent principles continue to answer all the purposes for which it was first contrived, than of him whose machine required the continual aid of the hand which first constructed it. It is owing to great inattention that this aversion to the operation of secondary causes has any influence on our minds. What do we mean by the introduction of secondary causes? How, in fact, do we infer the agency of any cause whatever? Would we ever have supposed any cause of the operations of nature, had they gone on without any order or regularity? Or would such a chaos of events, any more than a chaos of existences, have given us any notion of a forming and directing hand? No, surely. We see the hand of God in the regular and unvaried course of nature, only because it is regular and unvaried. The philosopher expresses this by saying that the phenomena proceed by unalterable laws. Greatly mistaken therefore are they who think that we supersede the existence of mind and of providence when we trace things to their causes. A physical law being an unvaried fact, is an indication, and the strongest possible indication, of an unerring mind, who is incapable of change, and must do to-day what he always did; for to change is to deviate from what is best.[1] The operations of unerring mind will therefore be regular and invariable.

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[1] Ferguson's Lectures on Ethics.

Physical laws, therefore, or secondary causes, are the best proofs of unerring wisdom. Such regularity of conduct is universally considered as an indication of wisdom amongst men. The wise man is known by the constancy of his conduct, whilst nobody can depend upon the future conduct of a fool.

And what astonishing evidences of wisdom do we not observe in the general laws of the material world? They will ever be considered by the intelligent philosopher as the most glorious display of inconceivable wisdom, which has been able, by means so few and so simple, to produce effects which by their grandeur astonish our feeble understandings, and by their inexhaustible variety elude all possibility of enumeration. Whilst the teachers of religion remain ignorant of the beautiful laws of nature, the great characteristics of the wisdom and goodness of the Almighty Creator, their hearers are deprived of much sublime pleasure; God is robbed of that praise which he would have received from an enlightened people; and the only worship he receives is tainted with mean notions of his attributes, and groundless fears of his power.

But besides those advantages which accrue to different classes of men from this study, there are some effects which are general, and are too important to be passed over unnoticed. That spirit of dispassionate experimental inquiry which has so greatly promoted this study, will carry with it, into every subject of inquiry, that precision and that constant appeal to fact and experience which characterize it. And we may venture to assert, that the superior good order and method which distinguish some of the later productions in other sciences, have been in a great measure owing to this mathematical spirit, the success of which in natural philosophy has gained it credit, and thus given it an unperceived influence even over those who have not made it their study.

The truths also which the naturalist discovers are such as do not in general affect the passions of men, and have therefore a good chance of meeting with a candid reception. Those whose interest it is to keep men in political or in religious ignorance cannot easily suspect bad consequences from improvements in this science; and, if they did, have hardly any pretext for checking its progress. Besides, discoveries accustom the mind to novelty; and it will no longer be startled by any consequences, however contrary to common opinion. Thus the way is paved for a rational and discreet scepticism, and a free inquiry on other subjects. Experiment, not authority, will be considered as the test of truth; and under the guidance of fair experience we need fear no ill as long as the laws of nature remain as they are.

More general advantages of philosophy.

Lastly, since it is the business of philosophy to describe the phenomena of nature, to discover their causes, to trace the connection and subordination of these causes, and thus to obtain a view of the whole constitution of nature, it is plain that it affords the surest path for arriving at the knowledge of the great cause of all, of God himself, and for forming proper conceptions of him and of our relations to him; notions infinitely more just than can ever be entertained by the careless spectator of his works. Things which to this man appear solitary and detached, having no other connection with the rest of the universe but the shadowy and fleeting relation of co-existence, will, to the diligent philosopher, declare themselves to be parts of a great and harmonious whole, connected by the general laws of nature, and all tending to one grand and beneficent purpose. Such a contemplation is in the highest degree pleasant and cheering, and cannot fail to impress us with the wish of co-operating in this glorious plan, by acting worthy of the place we hold amongst the works of God, and with the hopes of one day enjoying all the satisfaction which can arise from conscious worth and consummate knowledge; and this is the worship which God will approve. "This universe," says Boyle, "is the magnificent temple of its great Author; and man is ordained, by his powers and qualifications, the high priest of nature, to celebrate divine service in this temple of the universe." (B. B. B.)

PHYSIOGNOMY is a word formed from the Greek *φυσις, nature*, and *γινωσκω, I know*, and it is the name of a science which occupied much of the attention of ancient philosophers, but since the revival of learning has in a great degree been disregarded.

It does not appear that the ancients extended the compass of physiognomy beyond man, or at least animated nature. But the study of that art was revived in the middle ages, when those who treated of the subject strained their speculations far beyond the ancient limits. The extension of the signification of the term was adopted universally by those naturalists who admitted the theory of signatures; and physiognomy came thus to mean the knowledge of the internal properties of any corporeal existence from the external appearances. Baptista Porta, for instance, a physiognomist and philosopher of considerable eminence, wrote a treatise on the physiognomy of plants, in which he employs physiognomy as the generic term; and there is likewise a treatise *de Physiognomia Avium*, written, we believe, by the same person. In the *Magia Physiognomica* of Gaspar Schottus, human physiognomy is described as merely a subdivision of the science.

Boyle, too, adopts the same extensive signification. At present, however, physiognomy seems to mean no more than a knowledge of the moral character and extent of intellectual powers of human beings, from their external appearance and manners. In the Berlin Transactions for 1769 and 1770, there appears a controversial discussion on the subject of the definition of physiognomy, between Pernetty and Le Cat, two authors of some note. The former contends, that all knowledge whatever is physiognomy; the latter confines the subject to the human face. Soon afterwards appeared the celebrated book of Lavater, who defines physiognomy to be the art of discovering the interior of man by means of his exterior; but in different passages of his work he evidently favours the more extended signification of Pernetty.

Physiognomy was much cultivated in Egypt and India; and from these countries Pythagoras probably introduced the rudiments of this science, as he did those of many others, more important, into Greece. Plato also mentions the subject; and it is formally treated of by Aristotle, in a book which he has allotted to the purpose.

Pythagoras probably brought this science into Greece.

Physiognomy, he conceives, had been treated of in three ways. Some philosophers classed animals into genera, and ascribed to each genus a certain mental disposition, corresponding to their corporeal appearance; whilst others made a further distinction by dividing the genera into species. Amongst men, for instance, they distinguished the Thracians, the Scythians, the Egyptians, and whatever nations were strikingly different in manners and habits, to whom accordingly they assigned the distinctive physiognomical characteristics. A third set of physiognomists judged of the actions and manners of the individual, and presumed that certain manners proceeded from certain dispositions. But according to the method of treating the subject adopted by Aristotle, a peculiar form of body is invariably accompanied by a peculiar disposition of mind, and a human intellect is never found in the corporeal form of a beast. The mind and body reciprocally affect each other. Thus in intoxication and mania the mind exhibits the affections of the body; and in fear, joy, and other emotions, the body displays the affections of the mind.

From such facts he argues, that when in man there appears a particular bodily character, which by prior experience and observation has been found uniformly accompanied by a certain mental disposition, and with which therefore it must have been necessarily connected, we are in all such cases entitled to infer the disposition from the appearance. Such observations, he conceives, may be drawn from other animals as well as from men. For, as a lion possesses one bodily form and mental character, a hare another, the corporeal characteristics of the lion, such as strong hair, deep voice, large extremities, discernible in a human character, denote the strength and courage of that noble animal; whilst the slender extremities, soft down, and other features of the hare, visible in a man, betray the mental character of that pusillanimous creature. Upon this principle Aristotle treats of the corporeal features of man, and the corresponding dispositions, as far as these have been observed; he illustrates them by the analogy just mentioned, and in some instances attempts to account for them by physiological reasoning.

Aristotle was followed by Theophrastus, whose ethical characters form a distinct treatise on that branch of physiognomy which may be called the physiognomy of manners; and the latter was in his turn succeeded by others. There is indeed a considerable collection of Greek authors on physiognomy, entitled *Physiognomicæ Veteris Scriptores Græci, Græce et Latine*, 1780, in 8vo. From these authors, it appears that the science was much cultivated in Greece; but the professors seem soon to have connected with it something of the marvellous. This we are led to suspect from the story told by Apion of Apelles. The noviciates of the Pythagorean school were subjected to physiognomical observation by their teachers, and it is probable the first physiognomists by profession amongst the Greeks were of this sect. They, too, to whom, from the nature of their doctrines and discipline, mystery was familiar, were probably the first who, in Greece, exposed the science of physiognomy to disgrace, by blending it with the art of divination. From the period of which we have been treating to the close of the Roman republic, nothing worthy of remark occurs in the literary history of physiognomy. About the last-mentioned era, however, and thence to the decline of the empire under the later emperors, the science appears to have been cultivated as an important branch of erudition.

In the works of Hippocrates and Galen there occur many physiognomical observations. Cicero appears to have been peculiarly attached to the science. In his oration against Piso, and in that in favour of Roscius, the reader will at the same time perceive in what manner the orator employs physiognomy to his purposes, and find a curious instance of the ancient manner of oratorical abuse. Many physiognomical remarks are likewise to be found in the writings of Sallust, Suetonius, Seneca, Pliny, Aulus Gellius, Petronius, Plutarch, and others. That the science was practised as a profession in the Roman empire, ample evidence may be discovered in the writings of the authors just mentioned. Suetonius, for instance, in his Life of Titus, mentions that Narcissus employed a physiognomist to examine the features of Britannicus, and he predicted that the empire would devolve on Titus.

The science of physiognomy shared the fate of all others, when the Roman empire was overthrown by the northern barbarians. But about the beginning of the sixteenth century it began to attract notice; and from that time till the close of the seventeenth, it was one of the most fashionable studies. Within the space here mentioned appeared almost all the modern authors who have written upon this subject.[1]

Lavat celeb work.

Soon after the controversy in the Berlin Transactions, the great work of Lavater attracted the attention of the literary world. The work itself is magnificent; and that circumstance, as well as the nature of the subject, has contributed to extend its fame. With the scholastic and systematic method adopted by the physiognomists of the last and preceding centuries, Lavater rejected their manner of writing, which was dry, concise, indeterminate, and general. His own remarks are, for the most part, precise, and frequently founded on distinctions extremely acute. His opinions on the physiognomy of the ears, hands, nails, and feet of the human species, on hand-writing, on the physiognomy of birds, insects, reptiles, and fishes, are obviously premature, as hitherto no sufficient number of accurate observations have been made, in regard to these particulars, to authorize any conclusion. He has also erred in the opposite extreme, when treating of the important topic of national physiognomy, where he has by no means prosecuted the subject so far as facts might have warranted.

In the Berlin Transactions for the year 1775, there appears a formal attack upon Lavater's work by M. Formey. After disputing the propriety of the extensive signification applied by Lavater and Pernetty to the term physiognomy, Formey adopts nearly the same definition which we have proposed near the beginning of this article. He allows that the mental character is intimately connected with, and sensibly influenced by, every fibre of the body; but his principal argument against physiognomy is, that the human frame is liable to innumerable accidents, by which it may be changed in its external appearance, without any correspondent change of the disposition; so that it surpasses the extent of the skill of mortals to distinguish the modifications of feature which are natural from those which may be accidental. Although, therefore, the science of physiognomy may be founded in truth, he infers that the Deity only can exercise it. Formey further contends, that education, diet, climate, and sudden emotions, nay, even the temperaments of our ancestors, affect the cast of human features; so that the influence of mental character on these features may be so involved with, or hidden by, accidental circumstances, that the study of physiognomy must ever be attended with hopeless uncertainty.

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[1] Such as Cocles, Baptista Porta, Honoratus Nuquetius, Jacobus de Indagine, Alstedius, Michael Schottus, Gaspar Schottus, Cardan, Taisnierus, Fludd, Behmen, Barclay, Claromontius, Conringius, the commentaries of Augustin Niphus and Camillus Balbus on the Physiognomica of Aristotle; Spontanus, Andreas Henricus, Joannes Digander, Goclenius, Alexander Achillinus, Prætorius, Belot, Grataiorus, and others, noticed in the Polyhistor of Morhoff (vol. i. lib. i. cap. 15, sect. 4, and vol. ii. lib. iii. cap. i. sect. 4).

PHYSIOLOGY.

CHAPTER I.—GENERAL VIEWS OF PHYSIOLOGY.

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(1.) Physiology, or the science of animal life, has been variously defined by different writers. If the term were interpreted strictly according to its etymology, it would carry a meaning much more extensive than is warranted by common usage; for, being derived from φυσις, *nature*, and λογος, *discourse*, its proper signification should be, the *science of nature*. It might accordingly be understood to comprehend inquiries in every department of nature, both animate and inanimate; and might indeed be regarded as synonymous with *physics*, or *natural philosophy*, which are other expressions of corresponding import, but which at present are themselves restricted in their meaning to a special department of nature. There can be do doubt, indeed, that such must originally have been the real signification of these terms; but it is needless now to inquire by what gradual transitions they have at length come to bear such different, and even in some respects, opposite significations. If we were desirous of substituting a term which would accurately express the idea now associated with the word physiology, we should adopt that of *biology*, from βιος, life, first introduced by Treviranus, who has written a German work on this subject, which bears that title.

(2.) Natural philosophy, or physics, is now understood as designating that class of sciences, which have for their object the examination of the properties of lifeless matter; whilst physiology, in its modern acceptation, is in like manner limited to the consideration of the properties which are peculiar to organized and living bodies. The former is conversant only with nature in her dead or inanimate condition; the latter with nature endowed with life, and in all its various forms and modifications.

Thus mechanics, hydrostatics, and pneumatics, wholly relate to the general phenomena exhibited by matter in its solid, liquid, and gaseous forms; optics, which relates to the phenomena of light, together with electricity, magnetism, and the science of heat, which regard other classes of phenomena produced by peculiar agents, are all considered as branches of natural philosophy. Chemistry, which is concerned with the changes of composition in bodies, resulting from the mutual action of their particles at insensible distances, ranks also with the sciences relating to the properties of inorganic matter, and of which the assemblage constitutes what are more correctly termed in the present day, *the physical sciences*.

B ches of tural hi y.

(3.) On the other hand, the study of animated nature does not admit of the same extent of subdivision. Nature has indeed traced a broad and obvious line of demarcation between the *vegetable* and the *animal* kingdoms; the first being the province of *botany*, the second of *zoology*; both of which departments offer us a wide field of inquiry, and inexhaustible subjects of speculation. But it is in the animal world, more especially, that the busy and ever-changing scene is calculated to awaken the most lively curiosity, and inspire the deepest interest. The multiplied relations which connect us with the lower animals, the obvious analogies which subsist between them and our own species, and the striking evidences of power, intelligence, and benevolent design displayed in all the phenomena they present to our observation, confer on the study of animal life a degree of importance which belongs to scarcely any other study.

(4.) But the foundations of all science must be laid by drawing accurate distinctions among the objects which come within its cognizance; by making a strict analysis of the ideas it comprehends, and by establishing precise definitions of the terms it employs. As in all the other departments of human knowledge, we can arrive at general facts, or comprehensive laws, only by submitting to the previous task of ascertaining and collecting individual facts; so in natural history we find it necessary to subdivide our labours into that which takes cognizance of individual objects only, and that which inquires into their more general relations with one another. The first is properly the *history*, the second the *philosophy* of nature; and this distinction we may observe to run through all the branches into which the subject is divisible. It applies even to astronomy, in which the mere physical history of the phenomena forms a preliminary body of knowledge, yet subordinate to that higher range of inquiry which establishes connections between these phenomena, and unites them into comprehensive laws or theories. Mineralogy, again, must be studied as the foundation of geology; the former being the history of the actual appearances; the latter, the theory of the series of changes which have led to these observed phenomena. Thus, also, the external forms, and more obvious habitudes of plants, and their classifications in conformity with these forms and properties, constitute the subjects of *botany*, properly so called; whilst the study of their internal structure and economy, with relation to the more general phenomena of vegetation, is comprised under the head of *phytology*, or the physiology of vegetables.

Provinces of zoology and physiology.

(5.) In like manner, the proper objects of *Zoology* are to trace the external forms of animals, to distribute and arrange them in systematic order, and to record the particular facts relating to their history; that is, to the more obvious phenomena which they present to our observation. *Physiology* embraces a wider field of research, inquires into the connexions between the phenomena, and investigates the causes from which they spring, and the laws by which they are governed. The zoologist is content with collecting observations on the visible actions of animals, on their peculiar habits, modes of life, and the manifestation of those faculties with which they are respectively endowed by the Author of nature; a pursuit which affords inexhaustible sources of amusement, and furnishes abundant matter of admiration and of wonder. But the physiologist aims at far higher objects; and considering the external phenomena presented by animals as lying merely at the surface, seeks for information relative to the causes of all the facts which are furnished to him by zoology, by examining the interior structure of their bodies, by inquiring into the movements of that interior mechanism, and the sources of those various actions which give rise to all the complicated phenomena of life. An extensive and even boundless region of knowledge opens to his view in these highly curious and interesting subjects of research, constituting one vast science, which, although considerable progress has been made in it by the labours of our predecessors, is yet destined to occupy, for an incalculable period of time, the unremitting efforts of succeeding generations.

Organic phenomena.

(6.) The phenomena of living beings have a totally different character from the changes which take place in inanimate matter; and are with more difficulty subjected to the severe analysis required by inductive philosophy. The properties of inorganic bodies are of a simpler and more definite nature, and however variously they may be combined in their effects, admit, in general, of a reduction to general laws. This is most effectually accomplished by means of experiments, varied in such a manner as to reduce each class of phenomena to its simplest conditions, and afterwards combined in such a way as to allow of a comparison of their results with the appearances presented by nature, and of thus verifying their identity.

But it is hardly possible to pursue the same process of investigation to any extent in the diversified phenomena of organization. So complicated is the mechanism, and so fine the minuter structure of animal and vegetable bodies, that they elude the cognizance of our senses, even when assisted by the utmost refinement of optical and mechanical art. All that chemistry has yet achieved in disclosing to us the properties of different species of matter, and of their various combinations, falls infinitely short of that knowledge which could enable us to follow and to understand the curious and elaborate series of chemical changes which take place in the interior of the living body. Far less are we competent to trace the operation of those more subtle and mysterious principles, which are the springs of motion, and which regulate the actions of the machine, and connect the whole of its movements into one harmonious system. Judging from their more obvious effects, indeed, these principles appear to be quite of a different nature from those which produce the phenomena of the inorganic world. The series of changes which are exhibited by an animal or a vegetable, from the first moment of its separate existence, through all the stages of its growth, maturity, and decline, to the period of its death, are far too complicated and multifarious to admit of being reduced to one single principle, in the same way as the movements of the heavenly bodies, for instance, are reducible to the simple law of gravitation.

Vital principle.

(7.) Physiologists, indeed, not deterred by these difficulties, which are inherent in the subject of their researches, have in all ages attempted generalizations of this kind. They have considered all the actions and phenomena which are peculiar to living beings, and which differ from those exhibited by the same bodies after death, as resulting from the operation of a single principle of life. Different designations have been given to this power by different theorists; thus, some have called it the *vital principle*, others the *spirit of animation*, the *archæus*, the *organic force*; and many other appellations have been given to it, according to the particular taste or fancy of the writer. Nothing, indeed, can be more specious than this reference to unknown facts, which have a manifest connexion with one another, to a common principle of action, or in other words, to a vital power. The only idea we can form of life appears to imply the unity of such a principle. This idea, as is well remarked, by Cuvier, is suggested by the observation of a certain class of phenomena, succeeding each other in an invariable order, and having certain mutual relations with one another; yet it is but a vague and indistinct idea. We are ignorant of the nature of that link which unites the whole of these phenomena; but the existence of some such link forces itself upon our belief, and we are compelled to give it a particular designation, and speak of it as if it were something more than a mere fiction of the intellect.

(8.) Those who are unaccustomed to philosophical reasonings, may be, indeed, and often are, deceived by the employment of these abstract terms, and regard them as the expressions of a simple law of nature, of the same comprehensive, yet definite character, as those of gravitation, cohesion, heat, and electricity. A more careful and profound analysis, however, will convince us that the power inherent in organization, upon which its infinitely diversified actions depend, is not a simple agency, but a combination of several powers, not only different from the physical agents which actuate the inorganic world, but differing also very widely amongst each other. In order to arrive at this conclusion, however, it will be necessary to take a review of the phenomena themselves, and we shall therefore defer the consideration of this subject to a future chapter.

Final cause.

(9.) Although the peculiar nature of the phenomena which physiology embraces has hitherto baffled all our endeavours to obtain results of the same general and comprehensive nature as those which have rewarded our efforts in the purely physical sciences, yet other resources are open to us, capable of conducting us to a still more ample and inviting field of inquiry. Living nature is impressed with a character, which at once raises it to a higher order among the objects of human intellect, and invests the science which regards it with a more lofty and ennobling sentiment. Life is peculiarly characterised by the manifestation of INTENTION. Adaptation of means to an end is visible throughout the whole of this animated scene. Express design is palpably discernible in every formation, in every arrangement, in every series of changes which this vast theatre of nature displays. Utility is the governing principle of all; intelligence and power far exceeding the utmost stretch of our imagination, are revealed to us in language not to be mistaken, and carrying with it irresistible conviction. Thus, while the sciences of inorganic matter are founded on the relations of cause and effect, physiology takes cognizance more especially of the relations of means to ends, which the phenomena present to our view. Hence we obtain a new principle of arrangement among these phenomena; hence also arises a new source of interest, of a kind very superior to that which mere physical relations can ever inspire.

Study of functions.

(10.) The purposes to which, pursuing this new principle of arrangement, we can perceive the different structures which compose an animal body, are subservient, are termed, in the language of physiology, the *functions* of those parts. Life results from the exercise of these functions, and consists in the continued accomplishment of their respective objects. The principal object of physiology, then, is the study of the functions of life; that is, the investigation of the changes occurring in the living system with reference to their respective objects, and in their subservience to the maintenance of life, and the various purposes for which life was bestowed. We shall now proceed to take a general review of these functions, in order to establish a foundation for the divisions of the science we are now treating.

Gradation of functions.

(11.) The most cursory view that we can take of the phenomena of life will be sufficient to shew that the functions to which they are referable are of different degrees of importance with relation to the objects of life. Some are so closely connected with these objects, that their continued exercise is indispensable to the very existence of life, which would cease if they were for a moment interrupted. Others which are less immediately concerned in the actual maintenance of the vital actions, are yet essential to its preservation, and cannot, with safety, be suspended but for a very short interval. Some are only occasionally called into play, and others are so remotely useful, as to admit of lying dormant for a considerable period, or even of being dispensed with altogether. Some functions require for their performance the concurrence of others, and these, again, imply the exercise of many more. Some are of a more isolated nature, and have less connexion with the general system of functions. By studying these relations, we are enabled to trace a certain plan in the designs of nature, and a certain subordination of functions sufficient to guide us in our studies, and to enable us to trace out a tolerably connected order of subjects.

(12.) It will be useful, before proceeding to the details of the subject, to present our readers with a general sketch of the system of the animal economy, which may serve, indeed, the same purpose, as a map does to a traveller, imparting a general notion of the bearings and relations of the several objects of interest in the country he is about to traverse. We shall, for this purpose, embrace in one view that assemblage of functions which constitutes animal life in its most complete and perfect form, and in the attainment of its full developement.

morial tions.

(13.) All the functions of the animal economy, all the mechanical dispositions of the system, and all the movements of its parts, are subordinate to two great objects; first, the preservation and welfare of the individual being which they compose; and, secondly, the continuance of the race to which it belongs. It is evident that the first great purpose to be accomplished is the conferring of the powers of *sensation* and *perception*, these being the essential attributes of animal nature, and the characteristics which distinguish it from the mineral or vegetable world. Next to these is the power of *voluntary motion*, by which the animal is enabled to change its place, to procure for itself those objects which are necessary for its subsistence or gratification, and to repel those which are noxious or painful.

vous em.

(14.) The power of being affected by external objects, or of receiving impressions of which we are conscious, is connected, in the more perfect animals, with a part of the body having a more peculiar organization, and very remarkable properties. It is a soft and pulpy substance, of a whitish colour, with different shades of gray, opaque, and exhibiting slight traces of a fibrous structure. It is termed *medullary* or *nervous substance*. Of this substance are composed the *brain*, which is a large mass of medullary matter; and also the *nerves*, which have the appearance of white cords, extending from the brain to almost every other part of the body. The nerves establish a communication between these parts and the brain, so that impressions made upon the former, are communicated, along the nerves, and by their intermedium, to the brain, where they excite their appropriate sensations, corresponding to the nature of the impression, and to the structure of the organ that originally received it. By what agency, or in what way affections of the brain, thus induced, are instrumental in producing sensation, or how the sentient principle is connected with the physical constitution of the brain, are subjects of which we have no knowledge; nor have we, in our present state, the smallest ground of hope that the mystery in which it is involved, will ever be dispelled. Sufficient let it be for us that such is the fact; and resting on this as an ultimate fact, let us proceed in our inquiries, as to the occasions on which this power, assuming it to exist, is called into action.

(15.) Experience shews that the impressions conveyed by each nerve, or class of nerves, are of different kinds, for they are capable of being readily distinguished from one another by the percipient being whose brain receives them. Hence he acquires a knowledge of the presence, of the situation, and of the different properties of external bodies, which are the source of those impressions. The nature of that power with which the nerves are endowed is such as to convey the impressions from which this knowledge is derived, from the external organ to the brain, with a velocity that exceeds all imagination. This instantaneous transmission is evidently a provision of the highest importance both for the welfare and preservation of the individual.

xter- nses.

(16.) The different powers of perception, corresponding to different qualities of external objects, constitute the *external senses*; and each has its appropriate organ, furnished with its separate system of nerves. The skin, which is the organ of *touch*, receives the largest share of nerves, as it is evidently of the greatest consequence that the surface of the body should receive impressions from every substance with which it may happen to come in contact. The nerves of the skin are also susceptible of various impressions, besides those of mere impulse or resistance from solid bodies. They are affected, for instance, by variations of temperature; and when acted upon in any way that may be injurious to the part impressed, or to the system generally, they give suitable warning to the individual, by exciting a sense of pain. Hence he is admonished of impending evil, and is incited to the prompt adoption of the means of averting it.

Sight.

(17.) Next in importance to the sense of touch are those of *sight* and of *hearing*; but for the communication of distinct impressions relating to these senses, a much more refined apparatus is requisite than for that of touch. The structure of the eye is calculated to combine, upon a thin expansion of nervous substance, the *retina*, the rays of light proceeding from distant objects, so as to form a picture of these objects, and thus convey to the mind an exact knowledge of the relative situation of all their parts that are within the sphere of vision. Hence are derived the perceptions of their distance and position with respect to the observer.

Hearing.

(18.) In like manner are the sonorous undulations of the air collected into a kind of focus by the structure of the ear, and impressed upon the sensitive expansions of nervous matter in the inner regions of the organ. Thus an important avenue of communication is opened with the external world, highly useful in an infinite variety of ways.

Smell.

(19.) The existence and properties of various objects at a distance are also recognized by the sense of *Smell*, which enables us to appreciate the presence of the subtle effluvia which they emit, and which affect the atmosphere often to a considerable distance around. The olfactory nerves are adapted to the impressions of this kind, and are situated on the surface of those passages destined for the transmission of the air in subservience to another function hereafter to be noticed, namely, that of respiration.

Taste.

(20.) The sense of *Taste* is exercised on the substances employed as aliment, and has its seat at the entrance of the passages appropriated to the reception of food, and which are subservient to another class of functions presently to be described.

Sensation, &c.

(21.) The faculty of Sensation consists merely in the excitation of a simple mental change, known to every one, although incapable, in consequence of this very character of simplicity, of either analysis or definition. With reference to its physiology, we know that it is effected through the intermedium of certain nerves, connected, on the one hand, with the organs on which impressions of various kinds are made by the physical action of external objects, and on the other, with those parts of the brain, of which the physical affections are, by some inscrutable link, connected with the affections of the soul, or sentient principle. These simple and preliminary phenomena, composed of both physical and mental changes, are to be carefully distinguished from those subsequent operations that constitute perception, thought, volition, and the whole series of psychical phenomena, which we are in the habit of referring to a distinct branch of human knowledge, and which is generally denominated *Metaphysics*, *Psychology*, or the *Philosophy of Mind*; in contradistinction to *Physics*, *Somatology*, or the *Philosophy of Matter*.

(22.) There can be little doubt that these operations, which we are naturally accustomed to consider as being purely of a mental character, are, in some unknown degree, connected with physical changes taking place in the cerebral substance; but as we are utterly unconscious of these changes, and as we are totally precluded from arriving at any knowledge of their nature, or even of conceiving the manner in which a connexion between mind and matter has been established, we are compelled, in this branch of the inquiry, to direct our attention exclusively to the mental phenomena, to study their laws by the evidence of our own consciousness, and to resort to processes of analysis and methods of inductive investigation, in many respects different from those which are successfully employed in the more arable fields of physical science.

Whenever we are fortunate enough to trace some portions of the mysterious but broken thread which unites the material changes occurring in our bodily organs, with the operations of the intellect, or the affections of the soul, we may then occasionally re-enter the territory of Physiology; and while the two sciences are thus capable of being studied in conjunction, they will derive mutual advantage and illumination.

Voluntary motion.

(23.) Yet, with regard to the mere physiological study of the animal functions, it cannot escape our observation, that a vast variety of phenomena in the economy have a direct reference to the mental constitution of our nature, and are to be studied, with relation to final causes, in immediate connexion with these objects. Thus, although the special purposes served by the multiplicity, the curious arrangement, and intricate structure of the parts of the brain, are as yet wholly unknown, and as we still are, and shall probably ever remain, in utter darkness as to the mode in which they perform their respective offices as instruments of perception, thought, and volition, yet when we return to the observation of the bodily actions consequent on these mental processes, as well as contributing to their performance, we are enabled to resume our physiological inquiries, and trace the continuity of design in the exercise of the faculties of voluntary motion, by which the mind exerts a power of reacting on matter, employs its properties for beneficial ends, and exercises that partial dominion over nature, which has been granted to it by the Divine Author of its being. The possession of voluntary motion is directed, first, to enlarge the sphere of our perceptions, by directing our organs of sense to their respective objects; secondly, to bring the objects themselves within the reach of those organs by which they are to be examined; thirdly, to alter their forms and combinations, and modify them in various ways, so that the mind may, from these different modes of examination, derive accurate and extensive information of their properties, and apply these properties to use; and lastly, to effect the locomotion of the whole body, and thus extend widely the range of its operations, and spread the dominion of man over every kingdom of nature, and over every region of the globe.

Voice, &c.

(24.) But the relations of man with the external world comprehend a much larger and more important field, since they are not limited to the sphere of the material world, but embrace the intellectual and moral existences of other percipient and sentient beings. Through the intermedium of signs, the results of movements of our bodily organs acting on the senses, communications are established, not merely between mind and matter, but between mind and mind. Mutual interchanges take place, of thoughts, of opinions, of feelings, and of affections; and the value of existence is, to an incalculable degree, augmented by the operations of sympathy, the impulses of benevolence, and all the potent and benign influences of social union. Hence, physiologically considered, the function of the voice, and its modulation into articulate sounds, ranks as an important part of the animal economy.

Sensiferous and motor nerves.

(25.) The faculty of *Voluntary Motion*, like that of Sensation, is derived from the peculiar properties of the nervous substance. In the instance of sensation impressions are conveyed by means of the nerves from the external organs of sense to the general centre of the sensitive faculty, the brain. A similar power, we find, is exercised, though in a contrary direction, in transmitting the actions arising from the determinations of Volition, and which produce their first effects on the brain, towards those parts which are capable of executing these determinations. Modern discoveries have shewn, that for this latter purpose sets of nervous fibres are employed different from those instrumental in conveying sensitive impressions from the organs of sense to the brain. Hence a distinction is established between the *Nerves of Sensation*, and the nerves of motion, or the *Motor Nerves*.[1] While the nerves of sensation should properly be considered as commencing at the organs of sense, and terminating in the brain, the nerves subservient to volition have their proper origin in the brain, and proceed thence to the organs of motion. Let us next examine in what these organs of motion consist.

Muscul power.

(26.) The principal source of motion, in the animal body, resides in the *Muscles*, which taken altogether, usually compose by far the largest part of the bulk of the animal. Muscles consist of a collection of fleshy fibres, proceeding for the most part in parallel directions, and extending from the two points in the limb, or parts of the body, which are designed to be brought nearer to each other. The fibres of which the muscles are composed are endowed with the remarkable property of contracting, under certain circumstances, with prodigious power, so as to move the parts to which they are attached with sudden and enormous force. The impulse given to them by the nerves of volition, by which they are connected with the brain, in every effort of volition, excites them to contraction, and produces those movements of the body which are the objects of that volition.

(27.) The movements required for the purposes of animal life, are of course infinitely diversified in their kind, and scarcely admit of any distinct classification. Amongst the objects of these movements, however, we may notice two, which are of essential importance; the first is that of *Locomotion*, the second that of *Prehension*.

Locomo tion.

(28.) Locomotion is one of the faculties more particularly distinctive of animal life in opposition to that of vegetable. Plants are more or less rooted to the soil where they originally sprung: animals, destined to a wider sphere of action, are endowed with the power of transporting their bodies from place to place, on the one hand, of pursuing, and on the other, of flying from pursuit; of choosing their habitations, or of changing regions and climes according to their wants or necessities.

Prehen sion.

(29.) The power of detaining and laying hold of objects, is another mode in which the faculty of voluntary motion may be highly advantageous to the animal possessing it. With these may be associated the various actions requisite for defence or attack, rendered necessary by the conflicts incident to their condition.

Mechan functio

(30.) For the performance of all these actions, there is required in the first place, a solid and unyielding structure, capable of sustaining the weight of the body, and of furnishing to the muscles or agents of motion, fixed points of attachment. The *bones*, the union of which constitutes the *skeleton*, are provided for these objects. They are formed into separate pieces, with a view to their being moveable upon one another. Their extremities are connected together by smooth surfaces, which are bound together by firm bands or *ligaments*, bracing them on the sides where they are exposed to the greatest strain. An apparatus of this kind constitutes a *joint*.

(31.) The due performance of these mechanical objects, implies a variety of subsidiary contrivances and adjustments, too diversified in their nature and objects to admit of particular specification. It is evident that the particular texture of each part must be adapted to the actions it has to perform. Flexibility and compressibility are required in one organ; rigidity and hardness in another. Some parts must readily yield to an extending force, others must resist such a force with extraordinary tenacity. Some must exert elastic power, others must be devoid of this quality. Some textures must be permeable to fluids, others must deny them all transmission. Hence, the variety of structures composing the mechanical frame-work of the system.

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[1] We would suggest the propriety of designating these two classes of nerves respectively, by the terms *Sensiferous* and *Voluntiferous* as more distinctly expressing their proper functions.

ular re.

(32.) But in all the variations of conformation, it would appear that nature has employed the same ultimate structure as the basis of her work. All the solid parts of the animal fabric are formed of fibres, variously united and interwoven; in some cases only loosely connected, so as to constitute a spongy or cellular mass, flexible in every direction, and forming a medium of connexion between adjacent parts of various degrees of cohesion. This substance, which is found universally to pervade the body, is termed the *cellular substance* or *texture.* It is eminently endowed with elasticity, and thus contributes essentially to preserve the natural figure of every organ, and to restore it to its proper situation, after any displacement by a foreign cause.

brane.

(33.) When condensed into a firmer layer or sheet of animal matter, the same substance assumes the form of *membrane,* and is extensively employed as such, to supply organs with external coverings, or to afford them attachments to surrounding parts for the purpose of protection and support. Membranes are also used as barriers, for intercepting the communication of fluid from one cavity to another; and they are also employed to form receptacles for the retention of fluids, and tubes for conveying them from one part of the system to another.

ous es.

(34.) The fibrous structures, comprehending *ligaments, tendons,* and *fasciæ,* are composed of still a denser approximation of fibres, are endowed with a higher degree of toughness and strength, and are capable of exerting great resistance to any stretching force. Hence, they are extensively employed in the construction of parts where these properties are required.

ous c.

(35.) The organs specially appropriated to touch, are generally also those of prehension: and progressive motion is accomplished by means of limbs, which act either upon the ground, the waters, or the air, according to the element in which the animal resides. But, in order to give proper effect to these movements, the agency of levers is required; and we accordingly find a provision made for this purpose in the construction of the bones, which, as we have before observed, are capable of supplying the fulcra or fixed centres of motion, and allow of the application of the moving powers. It often happens that the actual attachment of muscles to the points required to be moved, would be attended with inconvenience. In this case, an intermediate structure is employed, analogous to that of a ligament, but here denominated a *tendon,* serving as a strap to connect the muscle to a distant bone, or other part on which the action of the muscle is to be exerted.

don.

(36.) All the functions, which have for their object some mechanical effort of the kind we have now described, may be comprehended under the general head of the *mechanical functions.*

rition, death.

(37.) The consideration of the chemical condition of the animal system, introduces us to a class of functions of a totally different nature from any of the preceding, yet equally essential to the maintenance of life. The solids and fluids of which organized structures are composed, differ materially in their chemical constitution from the products of the mineral kingdom. Their elements are combined by a much more complicated arrangement, and united by less powerful affinities; or rather the balance of affinities, by which they are held together, is more easily destroyed, and thus, proneness to decomposition is constantly present. One of the most remarkable and important of the operations of the vital functions, is to repress this tendency to decomposition; for no sooner is life extinct, than we find both the solids and fluids of the body hastening to assume new forms and combinations of their elements; and nothing can now prevent the final disorganisation of that fabric which so lately delighted the eye with its beauty, and in which dwelt the genial warmth of life, and the elastic vigour of youth. If we watch the progress of those changes which take place in the body, we shall find it characterised by a perpetual renovation of materials, continual losses of substance on the one part, being compensated by an equally constant supply on the other. From an atom of imperceptible minuteness we trace its gradual increase of size, by the reception of nutritious matter from without, by the incorporation of this matter with that which had before existed, by the consolidation of the fluid, by the extension of the solid parts. We see all the organs expanding by a slow, but uniform increase, and in regular proportion, till they arrive at a certain limit. Having attained this limit, the body remains stationary for a certain period; that is, the waste of substance is exactly compensated by the supplies furnished by the food received into the body. At length, however, the compensation is less perfectly maintained; the powers which carry on the functions begin to decline, the solids dry up and harden, and a general torpor gradually pervades the system. Life is sooner or later brought to a close by the natural progress of these changes, even if its course be not sooner arrested by causes of an accidental nature.

Chemical functions.

(38.) The functions of nutrition embrace a class of operations, destined to supply the materials wanted for the growth of the body, and for the supply of those materials which either may have been expended in the natural exercise of the other functions, or lost in various ways, or else employed in the reparation of injuries, which the organs may have accidentally sustained. The nutritive, or as they may also be termed the *chemical functions,* since they relate to the chemical condition of the body, comprehend a long series of processes, which, in order to study them successfully, require many successive subdivisions.

The first division includes all those functions which contribute to the reduction of the food to a substance of similar chemical composition with the materials of which the body already consists; processes which are comprehended under the general term of *Assimilation.*

The second and third divisions relate to the collection of the nutriment thus prepared, or assimilated, into a general reservoir; and its subsequent distribution throughout the body, so as to admit of being applied to use whenever it may be wanted. These objects are attained by the functions of *Absorption* and of *Circulation.*

A fourth division refers to the purification of the general mass of nutritious fluid existing in the great reservoir of the body, by the separation of its superfluous combustible portion, and more especially of its carbon; a change which is effected by the function of *Respiration.*

The last division of this class of functions comprehends the several processes by which certain materials are separated from the blood in a solid or fluid form; some with a view to their final expulsion from the system, some to answer purposes connected with other functions, and the remaining part being expended in repairing the waste which the solids of the body undergo in the exercise of their respective offices. To the former of these functions the term of *Secretion* is applied; whilst the last is more especially regarded as the proper and final process of *Nutrition.* We shall examine each of these divisions more particularly.

Assimilation, mastication, deglutition, and digestion.

(39.) Assimilation is effected by a long series of processes, which are partly of a mechanical and partly of a chemical nature. The food taken into the mouth is first masticated by the action of the teeth and jaws, so as to break down the cohesion of its parts, and prepare it for the chemical action of the fluids to which it is afterwards to be subjected. There is at the same time added to it a quantity of liquid, termed the *saliva,* prepared by a set of glands, to be hereafter specified, and poured out into the mouth in large quantities during the act of mastication. By these means the food is softened in its texture, and reduced to the form of a pulp, in which state it is swallowed, by the organs of deglutition, and conveyed through a tube called the *æsophagus* into the *stomach.* The stomach is a capacious bag, or receptacle, capable of holding a considerable quantity of food, and of retaining it for a certain period. The inner membrane which lines the cavity of the stomach prepares a fluid termed the *gastric juice*, which acts chemically upon the food in that cavity, while this food is at the same time subjected to a degree of pressure from the action of a set of muscular fibres which are interposed between the interior and exterior coats of the stomach. The food is also slowly moved by the successive contractions of these muscles, so that every part of it comes in its turn to be acted upon by the gastric juice, until the whole is converted into a soft and smooth mass of uniform consistence which is termed *chyme;* the operation itself by which this conversion is effected being termed *digestion.*

Chylification, lacteal absorption, and defecation.

(40.) The aliment thus digested, or reduced to the state of chyme, passes onwards from an orifice at the farther end of the stomach into a tube of great length, several portions of which have received different names, but which are comprised under the general term of the *intestines.* In the first portion, the *duodenum*, the aliment undergoes still further changes; it is mixed with two fluids, the one called the *bile*, which is prepared by a large glandular organ, termed the *liver;* and the other called the *pancreatic juice*, prepared by another gland, the *pancreas.* Secretions also take place from the inner membrane of the intestines themselves, and the result of the united action of all these fluids, aided by the movements imparted to the aliment by the contractions of the muscular fibres contained in the coats of the intestines, is gradually to convert part of what was chyme into a new substance called *chyle*, which is the most nutritious portion of the aliment, and has the appearance of a milky fluid. The chyle is received into a set of very minute tubes called *lacteals*, which are exceedingly numerous, and arise by open mouths from the inner surface of the duodenum and its prolongations, the *jejunum* and *ileum.* They collect the chyle together, and pour it into an intermediate receptacle, whence it is conveyed along a large tube, called the *thoracic duct*, into other cavities, of which we shall presently speak. That portion of the chyme which is not converted into chyle, descends into the lower portions of the intestinal canal, is collected in the larger intestines, of which the *colon* is the principal one, and finally ejected from the body.

Sanguification.

(41.) The next step in the assimilatory process is the conversion of the chyle into blood, a change which has been termed *sanguification.* It is in the great system of vessels which contain the blood already formed, and in the course of the passages through which the blood is moved, that this gradual change is effected. The great reservoir of this important fluid, on which the nutrition of every part of the body, and its maintenance in a state of action, immediately depend, is the *heart.* The thoracic duct opens into one of the veins or tubes leading directly to the heart; the chyle is therefore immediately conducted into this reservoir, and thoroughly mixed with the general mass of food.

Circulation.

(42.) The heart is a powerful muscular organ; from its cavity arise the trunks of large tubes, called *arteries*, which subdivide and ramify as they proceed in their course to every part of the body, being distributed in abundance to every organ, with a very few exceptions. No sooner are the cavities of the heart distended with blood, than the muscular structure which surrounds their cavities contract with enormous force, and propel their fluid contents through the system of arteries, sending it in one great wave, even to the extremities of its minutest ramifications. From these extremities of the arteries it passes into corresponding branches of another set of vessels, the *veins*, which proceed in the opposite direction, towards the heart, uniting in their course into larger and larger trunks, till they reach the heart, to which they deliver back the portion of blood that has thus percolated through every part of the body. No sooner has it again filled the cavities of the heart, than it is again sent with renewed force into the same arterial channels, and again brought back by the veins. The functions by which this circular course is given to the blood, is termed *the circulation.*

Secretio

(43.) The blood, in the course of its circulation, furnishes to all the organs the materials which are necessary for their growth, for the renovation of their powers, and for the supply of those fluids and other animal products which are wanted in various parts of the economy. The separation of these fluids, and the formation of these peculiar animal products, are the objects of another function, that of *secretion.* Particular organs are in most cases provided for the purpose of effecting these processes. These are the glands, which are variously constructed according to the particular offices they have to perform; each is furnished with an elaborate apparatus of vessels; and the fluid which is formed by them, is generally conducted to the place of its destination by a pipe, or *excretory duct*, as it is termed.

(44.) The fluids which are thus separated from the blood are, for the most part, applied to useful purposes in different parts of the economy; some for the repair of that loss of substance in the part of the body incident to the exercise of their respective functions, others for different subsidiary purposes related to those functions. The substance of the bones, for example, undergoes a gradual change during the whole of life; each particle is removed in succession and is replaced by others, so that in the course of time the whole substance of the body undergoes renovation. Two important functions are called into action for the completion of these processes; the first of these is concerned in the removal of the old and decayed materials; the second, in the due application of those which are to replace them.

Lymphat absorptio

(45.) The removal of those particles which have become useless, and whose presence might be injurious, is effected by a distinct set of vessels, called *lymphatics.* The lymphatics are met with in almost every part of the body; and resemble, both in structure and mode of distribution, the lacteal vessels already described. The mode of their origin is not well ascertained, but, like the lacteals, the smaller branches successively unite into trunks, which terminate either in the thoracic duct, or into the larger veins leading directly to the heart. Through these channels, then, it is that all the particles which require removal are conveyed away, and deposited into the general mass of circulating fluids. The function thus performed by the lymphatics in common with the lacteals, is termed *absorption.*

Nutrition growth, a reparatio

(46.) The function having for its object the reparation of the substance of the different organs, is designated by the general name of *Nutrition.* It includes the developement and growth of the parts, and their maintenance in the healthy state, that is the state in which they are fitted for the exercise of their several functions; as well as the restoration of what they may have lost from accidental causes, such as mechanical injuries.

When a bone is broken, for instance, a solid union is by degrees effected by the deposit of new ossific materials, consisting chiefly of phosphat of lime, which is secreted or separated from the blood by the irritated vessels in the neighbourhood of the injury. In all these cases the absorbents are also at work in modelling the shape of the part to be restored, in removing all roughnesses or angular projections, and making room for the new formations which are to take place. The functions of absorption and nutrition are thus, in some respects, opposed to each other, producing contrary effects, though both co-operating in the accomplishment of one final purpose, and balanced and adjusted to one another with that manifest intention. The general bulk of the body, and of its parts, varies according to the predominance of the one or the other of these actions of absorption and nutrition; wasting when the former is in excess; thriving and enlarging when the latter prevails.

(47.) There is one peculiar mode in which superabundant nutrition manifests itself. When the supply of nutriment is greater than what the wants of the system require, the superfluous portion is converted into an oily fluid, which is laid up in store for future use. This fluid is the *fat;* and it is accumulated in various parts of the body, and especially between the skin and the muscles, and in other places, where it may also serve a subsidiary purpose of mechanical protection against inequalities of pressure. The fat is thus useful as a soft cushion on which delicate organs, such as the eye, may move in security; and also as a convenient material for filling up hollows in various unoccupied situations. The chief use, however, of large accumulations of fat, is to serve as a magazine of nutriment, out of which the body may be supported in those seasons when the supply of food is deficient, and more particularly during those periods which are, by some animals, passed in a state of complete inactivity. This is the case in those animals which are said to *hybernate,* or continue during the whole of winter in a perfectly torpid state.

(48.) Whilst some of the products of secretion are thus employed in nutrition, others are subservient to the functions of particular organs. Thus, the tears are useful in washing away from the surface of the eye, dust, and other materials which might obstruct vision; the gastric juice is subservient to digestion; and the mucilaginous secretion of the wind-pipe and nostrils defend those passages from the acrimony of the air. But, in other cases, these secreted matters have noxious qualities; and it is the object of their separation from the blood, to get rid of them altogether. This is the case with the secretions from the kidneys, and from the skin, and perhaps, also, partly with that from the liver. These are termed the *excretions,* in contradistinction to the proper *secretions,* and the organs which separate them are termed the *emunctories.*

(49.) The organs which, in this sense of the term, must be considered as the principal emunctory of the body are the *lungs.* It would appear that the blood, from which the animal solids and fluids derive their nourishment, contains a larger proportion of carbon than what is required for the formation and reparation of these solids and fluids; the elements abstracted from the blood by the processes of secretion and nutrition, being principally oxygen, hydrogen, and nitrogen.

The continuance of these processes must tend therefore, to produce an accumulation of carbon in the blood; and accordingly we find that this fluid, in the course of its circulation, gradually acquires a darker colour. From being of a vivid scarlet hue in the trunks of the arteries, it has changed to a dark purple by the time it has reached the veins. It is returned to the heart, therefore, in a state unfit for the purposes of nutrition, and not proper to be again circulated through the vessels of the body. In order to restore it to its original state, it is necessary to deprive it of the ingredient it contains in excess, that is, of carbon, which, when thus present in the blood, is found to exert a positively deleterious power on the parts to which it is applied.

For this purpose the blood is transmitted by an appropriate system of arteries, to the lungs, where it is exposed to the influence of atmospheric air, alternately received into, and expelled from that organ. By a process which appears to be analogous to slow combustion, the superfluous carbon of the blood combines with the oxygen of the atmospheric air, and is expelled, in the form of carbonic acid gas, along with the air expired. The blood thus purified, and restored to its salutary qualities, is conducted back again, by a corresponding set of veins, to the heart, and is again sent, by the contractions of that organ, into the arteries of the body, and performs the same round of circulation as before. *Respiration,* which is the title of the function we have now been describing, completes this class, which we have termed the chemical functions of the economy.

The reproductive functions.

(50.) The three classes of functions we have been reviewing, namely, the *mechanical,* the *chemical,* and the *sensitive,* relate only to the preservation and welfare of the individual alone. But as nature has assigned a limit to the duration of life, it became necessary that a provision should be made for the multiplication of individuals, and the conservation of the race. Such, then, is the object of a fourth class of functions, namely the *reproductive functions,* including the processes of *fecundation,* of *evolution,* of *gestation,* and of *parturition,* and the auxiliary function of *lactation,* provided for the supply of the new-born infant with nourishment adapted to the tender condition of its organs of assimilation.

Developement.

(51.) Having studied the phenomena and the circumstances which lay the foundations of individual existence, the physiologist has next to occupy himself with the consideration of the long series of changes which intervene between the cradle and the grave, and constitute the "strange eventful history" of the physical life of man. He follows the rise and developement of the several organs, and the occasions on which their functions are called forth: he notices their entry on the stage of life, in which they are destined to play more or less important parts; he watches their progress, maturity, and decay, till they finally disappear from the scene, when their functions having successively declined, and passed away, the vital spark becomes extinguished, and the curtain drops on the fleeting drama of our probationary existence. A multitude of interesting subjects press on his attention in this division of his subject, so replete with wonder, and so calculated to impress us with exalted ideas of divine prescience, and of the unbounded resources of creative power.

To this department of physiology properly belong, first, the history of the changes which take place in the organs, during their natural course of developement, in what has been styled their *normal condition,* such as the formation of the vital organs, the process of ossification, the general growth of the body, the changes occurring at the period of puberty, the slow but sure progress of consolidation attending the decline of life, and the successive decay and obliteration of the faculties which precede death; and, secondly, the study of phenomena exhibiting the operation of those powers of repair and renovation, which exist in the constitution, and which are called forth only on certain occasions, when the organization has been injured or destroyed, or when the functions have been deranged or suspended, by various accidental causes.

Temperaments.

(52.) These topics introduce to our notice the varieties which are observable in different classes of individuals in the general mode in which the functions are performed with reference to their balance, or relative preponderance: conditions which constitute the different *temperaments,* as they are called, and which are severally characterised by peculiar external indications.

Varieties in the race.

(53.) Physiology, lastly, comprehends within the scope of its inquiries, those more strongly marked diversities that are met with in the inhabitants of different regions of the globe, and which appear to form separate races of mankind. These constitutional peculiarities, as shown by differences both in external conformation, and in the internal endowments of an intellectual and moral nature, are of so distinct and permanent a character, as to have suggested the hypothesis of their indicating, in a zoological sense, not merely varieties of a single species, but several different species of the genus *Man.*

Plan of this treatise.

(54.) The present treatise is intended to exhibit a condensed view of the actual state of our knowledge on all the subjects comprised in the above outline, and to conclude with a review of the progressive history of the science from the earliest periods to the present time.

Pathology.

(55.) It is hardly necessary to remark, that the province of *Physiology*, is restricted to the consideration of the phenomena of the living body in its perfectly *normal* or healthy state: while those which are presented when these limits of healthy action are passed, and the *abnormal*, or diseased state commences, are the subjects of another branch of science, denominated *Pathology*, no less interesting and important than the former, as furnishing the principles by which the art of medicine derives all its powers; but which, it must be obvious, must have its foundations laid in an extensive and correct knowledge of *physiology*.

Physiology founded on anatomy.

(56.) It is evident that the foundations of all physiological knowledge must be laid in a thorough acquaintance with the structure or internal mechanism of animals. The study of anatomy, indeed, derives its chief interest from its connexion with physiology; for unless viewed with reference to their uses, or subserviency to particular purposes, the examination of the forms and properties of the parts of a machine would be a barren and an irksome task. Let us imagine, for example, a person, who had never seen a ship, and had no idea of the object for which it is intended, to visit it for the first time, and to be at liberty to examine at his leisure every part of its rigging and internal construction. A restless curiosity might indeed lead him to handle the ropes and blocks, and climb upon every mast; to descend between the decks, and minutely inspect every part of its fabric; to explore, in a word, the whole anatomy of this most stupendous product of human ingenuity. But his labour would avail him nothing. The most complete survey would afford him no instruction, or leave any distinct impression as long as he had no principle to connect them in his mind. But let him review the same objects with an experienced guide, instructing him, as he proceeds, with the general purposes of the whole machine, and the particular uses of every part, as well as the mode in which they operate and concur in the production of the intended effect. Then it is that he will feel a real interest in the examination: then it is that he will attach due importance to each part of the inquiry. Perceiving the relations which connect the objects, and understanding the functions of the several instruments he sees, he is no longer perplexed and bewildered; individual facts arrange themselves in a natural order, and the whole forms in his mind one connected system of knowledge, readily retained and easily communicated.

The case is perfectly similar with regard to the body of an animal, of which anatomy lays open to us the structure. Dissection can only shew us that it consists of various parts, some hard, some soft, and others fluid. The harder parts, such as the bones, are of various forms, perforated by numerous apertures, and joined together in different ways. The soft parts are found to be composed of various kinds of textures, of which the elements appear to be collections of fibres or plates, curiously disposed and interwoven, so as to constitute a cellular or spongy tissue, and, occasionally, more extended layers of membrane. In every part we find innumerable tubes and passages, branching out and again uniting, in an infinite variety of ways. We arrive at cavities of different forms and extent, enclosing organs of various descriptions, or containing fluids which pass through appropriate channels of communication to very distant parts; composing altogether a vast and complicated system of mechanical and hydraulic apparatus. Thus whilst we confine our attention to the mere anatomy, all is perplexity and confusion; we are overwhelmed by the multiplicity of objects, and lost in the immense mass of unconnected detail. But no sooner do we study the parts of the animal frame with reference to their uses, and their subserviency to the several functions of the living body, than the whole appears under a new aspect. Aided by the light of physiology, we trace order and connexion in every part, and gather increasing delight and instruction as we proceed. The requisite adaptation of the organs to their respective offices, and the correspondence established between these offices, by which they concur in the same ultimate object, must ever excite our most profound admiration, and exalt our ideas of that infinite intelligence which planned, and that transcendent power and beneficence which executed the vast and magnificent system of creation.

CHAP. II.—APPLICATIONS OF PHYSIOLOGY.

Applica- tions o physio

(57.) Physiology claims our attention, not merely as an ornamental branch of speculative knowledge, but as a science of immediate and vast practical utility. Numerous are the occasions on which a scientific knowledge of the structure of our own bodies, and of the operations that are carried on within us, is highly valuable to its possessor; and more especially if combined with the more enlarged views derived from the study of comparative physiology. It may be useful here to point out some of the most important applications of physiological knowledge.

1. Me cine.

(58.) It is scarcely necessary to dwell on the utility of a knowledge of anatomy, enlightened by physiology, in its application to the art of medicine; for the very foundations of that art must be laid by these sciences. It is, however, proper to advert to the limited advantage which would accrue from such application if those sciences were confined to the human structure and the human functions, instead of comprehending within its range the whole of the animal creation. All the important discoveries of modern times with regard to the economy of the human body have been derived from observations made on the lower animals. That of the circulation of the blood, for instance, which has immortalised the name of Harvey, was obtained principally from this source. John Hunter, one of the greatest benefactors to the healing art in modern times, was so deeply impressed with the necessity of an extended study of comparative physiology, that he devoted his whole life to its cultivation, with an ardour and a perseverance that have been rarely equalled, and never surpassed; as is attested by the unrivalled museum of preparations in every department of comparative anatomy, which he formed by his own unaided exertions, and which will ever remain an imperishable monument to his fame.

(59) The various combinations of faculties, which are met with in the different tribes of animals, exhibit in a most striking manner the mutual dependence and relations of the animal and vital functions. As if with the express intention of assisting us in our physiological researches on the attributes of that vitality which eludes our experimental investigations, nature offers to our view, in the diversified structures of each successive order of animals, a series, as it were, of varied experiments; and exhibits the several organs under every degree of simplicity and complication of structures, and every possible mode of combination. The application of all this knowledge comes home to our own bosoms; for the human race is then viewed as composing a member of the great family of nature; and we ourselves, as well as all the individuals of that race, are placed under the governance of those general laws which regulate all animated beings. Our deepest interests, our future comforts and enjoyments, our powers of action, our intellectual existence, our capacities of feeling and of reasoning, all that renders life desirable, nay, that very life itself, are wholly dependent on the operation of those laws, and on the minutest results produced by their varied combinations. In a word, we ourselves are animals, and nothing that relates ever so remotely to animal life can be to us a matter of indifference.

(60.) Although the researches into comparative physiology necessarily imply a knowledge of the forms and history of the different races of animals, it tends to reflect, in its turn, the most important light on the science of zoology; and more especially on that department which relates to the classification of animals. All scientific knowledge must be founded on correct classification; but in zoology a methodical arrangement is indispensable; for scarcely any progress could be made without it. The number of animals in the habitable globe is immense, while our faculties and means of observation are extremely limited. Of insects alone, the number of distinct species which have been already determined considerably exceeds one hundred thousand. Of the other classes of animals, though less numerous, the catalogue of known species is at least half as great. Each of these races of beings has its distinct and characteristic form, its peculiar organization, habits, and faculties. It is obvious that if, at the outset of our inquiries, we were to attempt describing, or even of taking an inventory of all the living objects that presented themselves to our notice without regard to any principle of order, our attention would soon be distracted, and our memory overwhelmed by the confused accumulation of details; and it would not be possible to deduce from them any useful result. Classification affords the only clue which can extricate us from this intellectual labyrinth, which can resolve this state of chaos, and reduce this crude and indigested mass of materials into the form of regular science. It is only by a methodical arrangement of objects that we can arrive at the perception of the more extended relations which subsist among them, or establish general propositions, embracing a multitude of subordinate facts, and capable of an indefinite number of useful applications.

ifica-

(61.) In framing a system of classification of the animal kingdom, there are two objects which we may have in view; first, that of being able readily to ascertain the name of any animal which may present itself to our notice, and of recognising its identity with a species already known and described; or, secondly, that of becoming acquainted with the general nature and character of the animal in question; with the affinities which it has with others of the same class, and with the rank which it holds in the scale of animation. The first of these objects is attained by what are called *artificial methods* of classification; the second by what are called *natural methods*. Much error and confusion have prevailed in the reasonings of naturalists from their neglecting to discriminate the respective objects of these two kinds of methods, which nevertheless are perfectly distinct from each other.

icial ods.

(62.) In endeavouring to accomplish the first of these objects, we take, as it were, an inventory of nature, we record all her productions, and follow her in all her variations; we collect the fullest and most faithful description of every known species, and assign to each a particular name.

The end we have in view being simply to devise a ready method of identifying animals, we follow a process of this kind. We first unite those species which are most nearly allied to each other into one genus. We observe, for example, several species which have much resemblance to the stag; such as the rein-deer, the elk, the roebuck, the fallow-deer, the axis, the muntjac, and several others: we assemble all these into one genus, which we call the *deer* kind. By a similar process we form another genus of animals resembling the bull; such as the buffalo, &c. The genus *antelope* will, in like manner, comprehend the gazelle, the chamois, the nylghau, the oryx, the saiga, the gnu, and a multitude of others. In the same way, the *camelleopard*, the *goat*, *sheep*, *camel*, and *musk*, may be regarded as so many generic terms, each including a number of different animals, distinct in race, but similar in appearance. Having thus constituted the genera, we may apply to them the same principle of generalization that we did to the species; uniting them, according to their similitudes, into more comprehensive assemblages. Thus the genera above mentioned, having many features of resemblance, are considered as composing a tribe or order, to which Linnæus has given the name of *pecora*.

(63.) We may continue this process till we have gone through the whole animal kingdom; but it will then be necessary to adopt in some respects a contrary method; and instead of ascending as we have done from particulars to generals, to descend from generals to particulars. Regarding the animal kingdom as one entire subject, we must partition it into provinces, and again subdivide these into smaller portions. All these divisions and subdivisions must be founded upon distinct variations of external organs, and must be characterised by concise definitions, enumerating the leading circumstances common to all the animals they comprehend, and by which they may be contrasted with those included in the collateral divisions. The great primary divisions of the animal kingdom are the *classes;* the subdivisions of these form the *orders;* these comprehend the *genera*, which again include the separate races or *species;* while the ultimate ramifications of the system, expressive merely of diversities arising in the same race, constitute what are called *varieties*. By thus confining our attention to a small number of essential characters, we are enabled to ascertain, by a sort of analytical process, the name of any animal that we may wish to examine or identify. We have converted our rude inventory into a convenient dictionary of nature, where every object may be found at its appropriate place. The characters of the classes resemble in their office the initial letter of a word; the characters of the subsequent divisions that of the succeeding letters, conducting us with certainty and precision to the place we seek. The full developement of this method, and of the logic which should regulate it, and its successful application to natural history, we owe to the genius and industry of Linnæus, to whom the science will ever have to record a lasting obligation.

(64.) But however perfectly we may have accomplished the purpose we had in view in these artificial arrangements, it is impossible not to perceive that we have obtained them by the sacrifice of that order which nature herself points out. A strict adherence to any arbitrarily assumed principle of classification, is, in truth, incompatible with the preservation of the natural affinities of animals. Thus, in the system of Linnæus, the order *primates*, among the mammalia, presents the incongruous association of man with monkeys, lemurs, and bats. In the order *belluæ*, the horse is placed by the side of the hog. The *feræ* offer us the unnatural association of the seal, the dog, the bear, the opossum, the hedgehog, and the mole, merely because these animals, in most respects totally dissimilar, happen to agree in having the incisor teeth of a conical shape. The continual violation of natural analogies, which is yet necessarily incident to all artificial systems, has exposed them to much censure and ridicule, from those who forget that the purpose for which they are framed, is that of convenient reference, and that it is essential to arrangements adapted to that end, that they should be arbitrary. As well might it be made the subject of complaint, that, in a dictionary, words having very different meanings, are found placed in juxtaposition.

Natural methods.

(65.) Cuvier has justly remarked that a perfect natural method should be the expression of the science itself, that is, of its most general propositions. By assembling animals in groups, according to their general resemblances in the more important circumstances of their organization and functions, we are enabled to connect them under one description, and afterwards apply to each individual species all the particulars comprised in this description, and thus we obtain more or less comprehensive statements, or, as it were, zoological laws, enabling us both to acquire and to retain the facts with greater facility, and to apply them with readiness in every case; in a word, it gives us the entire command of that knowledge, by imparting to it the form of science. The tribe of *pecora*, formerly mentioned, may be taken as an excellent example of a natural family of animals; for they consist of species which bear a striking resemblance with one another in form, organization, and manners. If we meet with a new animal having one or two of the leading characters of this tribe, we deduce at once all the most important features of its history. We know, for instance, from its possessing a double hoof, that it belongs to this tribe, and consequently that it feeds on herbage, that it has four stomachs, and that it ruminates its food; that it belongs to a species disposed to assemble in flocks or herds, and that it has a disposition to be domesticated. We may pronounce that its upper jaw has no incisor teeth, and so forth.

(66.) It is evident that from the discovery of these analogies, on which the arrangement into natural families is founded, we must resort to the aid of comparative physiology. It is this science alone that can teach us to discriminate the circumstances which are of real importance in the animal economy, and on which their very nature and character depend. The immense progress which has been made in this branch of knowledge since the time of Linnæus, has enabled us to determine with much greater precision the relative affinities of animals, and the rank which each tribe is entitled to hold in the natural system of classification.

Method of Duméril.

(67.) Attempts have often been made to combine these two methods into one, by a sort of mutual compromise between them, that is, by an arrangement partly natural and partly artificial, to obtain the principal advantages of both. The most perfect specimen of this union of the two methods is that of Duméril, which he has published under the title of *Zoologie Analytique*. The characters on which his divisions are founded are distributed in a strictly analytical order, and they conduct us to classes much more natural than those of Linnæus. Thus he divides the Linnæan class of insects into two, namely, *crustacea*, and *insects* properly so called. The very miscellaneous class of *vermes*, in which animals very dissimilar in their nature had been thrown together as it were in a lumber closet, compose in this system the more natural assemblages of *mollusca*, *vermes*, and *zoophytes*. Duméril has pursued this plan throughout the whole of the animal kingdom, reducing all the characters which lead to the determination of classes, orders, families, and genera, to the form of synoptic tables.

Cuvier.

(68.) The arrangement which makes the nearest approach to a natural distribution is that adopted by Cuvier, in his celebrated work entitled *Le Régne Animal Distribué d'après son Organization*; as it is founded chiefly on the structure of the organs most essential to life, and having most influence in determining the intelligence, sensibilities, activity, habits, and manners of animals. Physiology is, in fact, the basis of Cuvier's classification, for it proceeds on the following principles.

(69.) The powers of sensation and of voluntary motion being the chief attributes of animal life, it follows that the organs of primary importance in the economy are those which are immediately subservient to the performance of these functions. They are, as we have seen, the organs composing the nervous system; and the general form and distribution of the nervous system, therefore, should lay the foundation of the primary divisions of the animal kingdom. There appear to be four general types or models of structure of these organs presented in the animal creation. The first consists of a brain, or large mass of nervous substance, from which a cylindrical process, called the *spinal marrow*, is continued; and these are protected respectively by the bones of the skull, and by a series of bones, called *vertebræ*, which form a jointed column along the whole length of the back. Animals formed on this construction are called *vertebrated animals*, a division which comprehends all the higher classes of the animal kingdom, namely, *mammalia*, *birds*, *reptiles*, and *fishes*.

In the second form of the nervous system, there is properly but one central mass of nervous substance, or brain, without any spinal marrow, and from this mass filaments of nerves proceed, in various directions, to be distributed to all the other parts. This division comprehends all the *mollusca*, including both the mollusca and testacea of Linnæus.

The third form is that of a longitudinal series of masses connected together by lateral filaments, and sending out, as from so many centres, ramifications of nerves. This structure is the distinctive mark of *articulated animals*, and may be recognised in insects, and worms properly so called.

The fourth and last division of Cuvier, he denominates *radiated animals*, in which, wherever nerves are found, they appear as a number of equal masses disposed in a circle, and sending out fibres, which diverge like rays from a common centre. Hence the whole body of the animal, or at least some of its principal organs, has a radiated or star-like form. This is the case with the *asterias*, *medusæ*, *polypi*, and all the other animals comprehended under the name of zoophytes.

As frequent reference will be made, in this treatise, to the zoological classification of Cuvier, we shall here give a table of the principal divisions which it comprises, together with examples of animals included in each order.

I. VERTEBRATA.

1. MAMMALIA.

1.	Bimana	*Man.*
2.	Quadrumana	*Monkey, ape, lemur.*
3.	Cheiroptera	*Bat, colugo.*
4.	Insectivora	*Hedgehog, shrew, mole.*
5.	Plantigrada	*Bear, badger, glutton.*
6.	Digitigrada	*Dog, lion, cat, martin, weasel, otter.*
7.	Amphibia	*Seal, walrus.*
8.	Marsupialia	*Opossum, kanguroo, wombat.*
9.	Rodentia	*Beaver, rat, squirrel, porcupine, hare.*
10.	Edentata	*Sloth, armadillo, anteater, pangolin, ornithorynchus.*
11.	Pachydermata	*Elephant, hog, rhinoceros, tapir, horse.*
12.	Ruminantia	*Camel, musk, deer, giraffe, antelope, goat, sheep, ox.*
13.	Cetacea	*Dolphin, whale.*

2. AVES.

1.	Accipitres	*Vulture, eagle, owl.*
2.	Passores	*Thrush, swallow, lark, crow, sparrow, wren.*
3.	Scansores	*Woodpecker, cuckoo, toucan, parrot.*
4.	Gallinæ	*Peacock, pheasant, grouse, pigeon.*
5.	Grallæ	*Plover, stark, snipe, ibis, flamingo.*
6.	Palmipedes	*Auk, grebe, gull pelican, swan, duck.*

3. REPTILIA.

1.	Chelonia	*Tortoise, turtle, emys.*
2.	Sauria	*Crocodile, lizard, gecko, chameleon.*
3.	Ophidia	*Serpents, boa, viper.*
4.	Batrachia	*Frog, salamander, newt, proteus, siren.*

4. PISCES.

1.	Acanthopterygii	*Perch, mackerel, sword-fish, mullet.*
2.	Malacopterygii	*Salmon, herring, pike, carp, silurus, cod, sole, remora, eel.*
3.	Lophobranchii	*Pipe-fish, pegasus.*
4.	Plectognathi	*Sun fish, trunk-fish.*
5.	Chondropterygii	*Lamprey, shark, ray, sturgeon.*

II. MOLLUSCA.

1.	Cephalopoda	*Cuttle-fish, calamary, nautilus.*
2.	Pteropoda	*Clio, hyalæa.*

3. Gasteropoda	*Slug, snail, limpet, whelk.*
4. Acephala	*Oyster, muscle, ascidia.*
5. Brachiopoda	*Lingula, terebratula.*
6. Cirrhopoda	*Barnacle.*

III. ARTICULATA.

1. ANNELIDA.

1. Tubicola	*Serpula, sabella, amphitrite.*
2. Dorsibranchia	*Nereis, aphodrite, lob-worm.*
3. Abranchia	*Earth-worm, leech, nais, hair-worm.*

2. CRUSTACEA.

1. Malacostraca	
Decapoda	*Crab, lobster, prawn.*
Stomapoda	*Squill, phyllosoma.*
Amphipoda	*Gammarus, sand-hopper.*
Læmodipoda	*Cyamus.*
Isopoda	*Wood louse.*
2. Entomostraca	*Monoculus.*

3. ARACHNIDA.

1. Pulmonalia	*Spider, tarantula, scorpion.*
2. Trachealia	*Phalangium, mite.*

4. INSECTA.

1. Aptera	*Centipede, podura.*
2. Coleoptera	*Beetle, glow worm.*
3. Orthoptera	*Grasshopper, locust.*
4. Hemiptera	*Fire-fly, aphis.*
5. Neuroptera	*Dragon-fly, ephemera.*
6 Hymenoptera	*Bee, wasp, ant.*
7. Lepidoptera	*Butterfly, moth.*
8. Rhipiptera	*Xenos, stylops.*
9. Diptera	*Gnat, house-fly.*

IV. ZOOPHYTA.

1. Echinodermata	*Star-fish, urchin.*
2. Entozoa	*Fluke, hydatid, tape-worm.*
3. Acalephæ	*Actinia, medusa.*
4. Polypi	*Hydra, coral, madrepore, pennatula.*
5. Infusoria	*Brachionus, vibrio, proteus, monas.*

Theory of continuous gradation.

It has long been a favourite notion with speculative naturalists, that organized beings might be arranged in a continued series, every part of which, like the links of a chain, should be connected with that which preceded and that which followed it. Linnæus was even impressed with the idea that nature, in the formation of animals, had never passed abruptly from one kind of structure to another. But the idea of a chain, or continuous gradation of being, was cherished with enthusiastic ardour by Bonnet, who, assuming man as the standard of excellence, attempted to trace a regular series, descending from him to the unorganized materials of the mineral world. Many other writers have adopted this speculation; but none have carried it to a more extravagant length than Lamarck, who blends it with the wildest and most absurd hypothesis that was ever devised, to account for the diversities of animal structures. He conceives that there was originally no distinction of species, but that each has, in the course of ages, been derived from some other less perfect than itself, by a *spontaneous* improvement in the race. He believes that the animalcula of infusions gave birth, by successive transformations, to all other animals; aquatic animals acquiring feet and legs, fitting them for walking on the ground, and, after a time, being converted into wings, merely from the long continued operation of a desire to walk or to fly.

(70.) In support of the theory of continuous gradation many anomalous animals are produced as instances of links of connexion between different classes of animals. The bat has been regarded as one of these intermediate links between mammalia and birds. The cetaceous tribe, including the *whale, cachalot, dolphin,* and *narwhal,* though properly belonging to the class mammalia, make an apparently near approach to the tribe of fishes. The ornithorhyncus is allied both to quadrupeds and to birds. Many similar examples might be produced among the inferior classes of the animal kingdom. A little attention, however, will soon enable us to perceive that they occupy but small portions of the wide spaces intervening between different orders of animals. Even in the best arranged systems, such as that of Cuvier, we discover innumerable chasms wholly unoccupied, between adjacent orders; and in many instances animals, which are scarcely in any respect allied to each other, are placed in immediate sequence. This defect, as I have already observed, is unavoidable, because it is inherent in the very nature of the subject. Instead of a single continuous line, nature presents us with a multitude of partial series, with innumerable ramifications, and occasionally a few insulated circles. If metaphor must be employed, it would be better to say, that instead of being a chain, the natural distribution of animals offers the idea of a complicated network, where several parallel series present themselves, and are occasionally joined by transverse or oblique lines of connexion. The great divisions of Cuvier represent these principal parallel series. The last, however, or that of the *radiata*, appears to be the least perfect of these series, and might with advantage be farther divided. On the subject of natural classification Mr. Macleay[1] has advanced a hypothesis, which he supports with some ingenuity, namely, that the real types or models of structure may be represented by a circular or recurring arrangement; and he gives a number of instances in which this principle appears very happily to apply. But speculation on these subjects can lead to satisfactory conclusions only on the supposition that an extensive comparison of organs has been instituted throughout the whole of the animal kingdom.

3. Application to geology.

(71.) A scientific knowledge of the organization and functions of animals is valuable, not only in its application to zoology, but also in reference to many other sciences, such as geology, with which it might at first view appear to have but little connexion. By attending to the arrangement of mineral bodies as they occur in nature, we have sufficient proofs that the earth has undergone frequent and considerable changes prior to the existence of any living beings. But we find, besides, a great number of strata, which contain unequivocal remains of vegetable and animal bodies. A large proportion of these are shells, exuviæ of zoophytes, and other marine animals. We also find, in other strata, a multitude of fossil bones, and teeth of various quadrupeds and reptiles; and occasionally, but more rarely, of birds and fishes. Whole mountains and extensive districts appear to be composed entirely of these animal remains. It is by the aid of comparative anatomy and physiology alone that we are enabled to compare these relics of antiquity with similar facts of living or recent animals, to discover their differences or identity, and to deduce certain conclusions with regard to the nature, habits, and characters of the animals to which they had belonged; and by studying their relation with the strata in which they are found, to draw inferences with regard to the changes which must have taken place in those parts of the earth, inferences which are of the highest importance towards establishing a correct theory of those changes. The difficulties attending researches of this nature were of course exceedingly great; but they have been at length surmounted by the persevering zeal and industry of modern naturalists. In these arduous investigations Cuvier stands pre-eminent; and his labours have been rewarded with a number of highly interesting results. The great principle which he has assumed as the foundation of his researches, is that every organized individual constitutes a system of itself, of which all the parts are connected to each other by certain definite relations. In passing from each of these structures to that of other animals in the natural series, we find that all the changes of form which take place in any one organ are accompanied by corresponding alterations in the form of every other organ; so that by the careful application of certain rules, deduced from this observed reciprocal dependence of its functions, we are enabled to ascertain with considerable certainty the forms and habits of animals, of which only small fragments have been preserved. We have already given an instance of this mode of reasoning as applied to ruminant animals. By following this guide Cuvier ascertained and classed the fossil remains of nearly 100 different quadrupeds in the viviparous and oviparous classes. Of these above seventy were distinct species, hitherto unknown to naturalists.

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[1] Macleay, *Horæ Entomologicæ*, or Essays on Annulose Animals, 1821.

It appears from these researches that the earth has sustained more numerous convulsions than had before been suspected, and that these must have been separated by considerable intervals of time; that the ocean has deposited various strata in regular succession; that the species of animals whose remains are found in these strata change with every variation in the nature of the deposit, and become more and more analogous with the living animals of the present day, in proportion as the deposits have been of more recent date. It appears from an examination of these fossil remains, that the sea must have retired at intervals from the districts it had formerly covered, and left dry land, affording habitation for large quadrupeds; and that after a certain unknown space of time, the sea has suddenly returned to the same spot, has destroyed all the terrestrial animals, and has formed subsequent deposits of shells and other marine productions.

These sudden irruptions and recessions of the ocean, which have occurred several times in the same district, must have been attended with extensive destruction of animal life. Whole races have perished irretrievably, and are known to us only by the durable memorials they have left behind of their own existence, and of the several epochs of antediluvian chronology.

(72.) The study of the fossil remains of animals has also extended our views of the animal kingdom; it has in many instances supplied chasms which had occurred in the natural series, and has enlarged our ideas of the extent of creative power. Another important conclusion which has resulted is, that the human race has been the last created; for nowhere do we find any vestiges of human bones. These researches tend also to throw light on the history of mankind, and to refute the pretensions to high antiquity which have been arrogated by certain nations, and particularly the Chinese, &c. which Voltaire and other modern philosophers had so zealously defended. All that science has brought to light, indeed, is in conformity with the testimony of the sacred writings, when rationally interpreted, and may even be adduced as illustration of their truth. Geology and comparative physiology concur with these writings in teaching us that man was the last act of creative power; that a great catastrophe took place on the surface of the globe a few thousand years ago, during which the sea covered for a time every part of the land; and that the subsequent diffusion of the population of the earth is of comparatively recent date. It is pleasing to see conclusions, derived from such different sources, converging to the same points, and affording each other that reciprocal confirmation which is the invariable concomitant and surest test of truth.

(73.) The enlarged views to which we are conducted by the study of comparative physiology afford us a glimpse of some of the plans or models of structure which appear to have been followed in the formation of the animal world. The analogies of form discernible in corresponding organs, throughout a very extensive series of tribes, have been lately traced and developed with extraordinary care by the modern naturalists of the French and German schools, and especially by Cuvier, Blainville, Savigny, Geoffroi St. Hilaire, Oken, Carus, and Milne Edwards. The conclusions they have drawn from their labours, though sometimes overstrained, are always ingenious, and in general satisfactory; and they strongly tend to prove, that several distinct types, or standards of figure, have been adhered to in all the multiplicity of forms with which it has pleased the Author of nature to diversify the animal creation.[1]

4. App
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logy.

(74.) These inquiries, however, suggest still higher subjects of contemplation. They illustrate the connexion and relationship of every part with the rest of the system. They prove the unity of design with which the system has been planned and executed. They demonstrate the perfection with which all its parts are mutually adjusted, and the harmony which pervades the whole. The evidences of express design and contrivance are so distinct and palpable, and they so multiply and accumulate upon us as we advance, that they may almost be said to obtrude themselves on our notice; and we cannot avoid being impressed with the notion of its being intended that we should observe them. Whilst the purpose to be answered continues the same, the means are varied in every possible manner, as if designedly to display to us the exhaustless resources of inventive power, and the supreme intelligence with which that power is wielded. Nor is it possible to overlook the general object to which every thing so manifestly tends in the system of animal existence. Every element in every part of the habitable globe, teems with life, and that life is replete with enjoyment. Happiness is unquestionably the great object of animal existence. The benevolence which pervades the whole system of creation, is no less conspicuous than the power and intelligence from which it emanated. Revealed religion is thus in unison with the theology derived from the contemplation of nature, and the lights of modern science.

(75.) The facts derived from comparative physiology which more especially support the arguments of natural theology have been collected by authors who have written professedly on the subject. Derham's work, entitled *Physico-Theology*, has been deservedly held in estimation; but since the time it was published, which is now above a century, the sciences have been prodigiously extended. Dr. Paley, in his *Natural Theology*, has produced a great multitude of facts and observations in support of the same arguments, has applied them with singular felicity, and impressed them with the most fascinating perspicuity and eloquence. But his object being purely theological, he has not professed to adhere to any scientific order in stating them. The design of the Bridgewater Treatise, already referred to, is to supply this desideratum, by presenting the details of animal and vegetable physiology, arranged according to the functions to which they relate, or in other words, in reference to final causes. As theological arguments, the value of these facts cannot fail to be better appreciated when they are studied in all their bearings, and as forming a part of the science to which they belong. It is by the aid of genuine science alone, that we can avoid the dangerous error of building arguments, on so momentous a subject, upon equivocal or unstable foundations, and of injuring a cause already established upon incontrovertible grounds, by weak and inconclusive evidence.

(76.) It has been too hastily inferred, from the abuse which has too often been made of philosophical inquiries, that they are to be avoided as dangerous, and even pernicious; and that of the fountain of philosophy, as of the Pierian spring we should "drink deep," or abstain from tasting. Superficial knowledge has often been decried as mischievous, and extremely liable to abuse. The hackneyed maxim of Pope, that "a little knowledge is a dangerous thing," has furnished a ready text for those who declaim against all attempts to render science popular, and to include it as a branch of general education. Willing proselytes to this doctrine will always be found among those whom indolence or frivolity render averse to mental exertion, when bestowed on subjects not immediately connected with the common concerns of life, as well as among those who, already enjoying some of the advantages of knowledge, are desirous of securing to themselves the monopoly of those advantages. But their sophistry is soon detected when we examine into the real meaning of the expressions they employ. What is commonly denominated superficial knowledge, may certainly be useless, or even dangerous; but the mischief or danger arises, not because it is superficial, but because it is incorrect. It is error, under the guise of knowledge that alone deserves such reprobation. The value of information is to be estimated much more by its accuracy, than by its extent. Although it may be true that there is no royal road to science, it is equally true that many are the roads that lead astray; and that much fruitless labour may be spared by having that one pointed out which leads directly to the object we wish to attain. Though the distance we have to travel cannot be abridged, yet the path may be rendered smoother, and the velocity of our progress accelerated, by availing ourselves of such guidance as may be afforded by concise treatises, which, however superficial in appearance, or popular in their garb, are yet, as far as they go, perspicuous, accurate, and comprehensive.

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[1] See the Bridgewater Treatise on Animal and Vegetable Physiology, where this subject is enlarged upon, and especially the chapter on "Unity of Design." Vol. ii. p. 625.

CHAPTER III.—ARRANGEMENT OF FUNCTIONS.

tempts an ar- gement func- ns.

(77.) The general review we have taken, in our introductory chapter, of the objects and mutual connexions of the functions of the animal economy will furnish us with the principles on which the methodical arrangement and classification of those functions should be established. Various attempts have been made by different systematic writers on physiology towards the accomplishment of that object; but they have generally been deficient in that logical precision, which alone can ensure entire comprehensiveness of every branch of the subject, and at the same time convey clear perceptions of the bearings of every part to one another. Some physiologists have limited their views to the human economy, or that of animals which most nearly resemble man; others have framed their systems so as to embrace the whole animal kingdom, and even all beings endowed with life. Some have been wholly governed by anatomical considerations, regarding mere structure as the basis of physiological distinctions; others, overlooking the unity of purpose in each function, and pursuing their subdivisions to an excessive degree of minuteness, have overloaded the subject by needless multiplication and superfluity of detail. Many have introduced confusion by a loose and vitious nomenclature, derived from partial or hypothetical views; which were often tinctured with mysticism, and which, by biassing their judgments, have betrayed them into a wide field of delusion and of error.

nal mis- en for ysical ses.

(78.) Another source, to which the greater part of the mistakes, pervading all the systems of physiological arrangement that have been hitherto framed, may be traced, is inattention to the essential distinction which exists between physical and final causes. The study of the phenomena of life differs from all the other branches of philosophical inquiry, by its involving considerations relating to both these kinds of causes; the latter of which introduces a totally new principle of arrangement, wholly inapplicable in those sciences which concern the physical properties of inert and inorganic matter. The rules of a strictly philosophical induction, which alone can guide our steps in the pursuit of these sciences, must be greatly modified, and in some measure superseded by those derived from another department of human knowledge; namely, psychology. The knowledge of those general facts, which, when once established, and the conditions on which they depend ascertained, constitute what are called the laws of nature, is obtained first, by comparing together phenomena and uniting in one class such as are of the same kind, and carefully separating them from others which are essentially different; and next, by endeavouring to remove all extraneous influences, so as to reduce each class of phenomena to its simplest conditions; an object to be attained by *experiments*, that is, by varying the circumstances under which they occur, and also by combining them in different ways, so as to enable us to verify our theories, by comparing their results with the actual observation of nature. But the attempt to apply the same process of induction to the physiology of organised beings, is attended with peculiar difficulty; for while the changes which occur in the inorganic world exhibit the operation of forces or agents characterized by their simplicity, their constancy, and their uniformity, the phenomena presented to our view by living beings, so prodigiously varied in their form, so extensively spread throughout every element, every clime, and every habitable region of the globe, and so infinitely diversified in their nature, and complicated in their connexions, are calculated to baffle the efforts of the most cautious reasoner, and elude the penetration of the most sagacious inquirer after truth. The resources of experimental research are here extremely narrowed, in consequence of the simultaneous and connected operation of a great number of powers, which prevent us from studying the influence which each would exert when isolated from the rest, and ascertaining the laws which are peculiar respectively to each. Hence it is that we have hitherto made but very imperfect approaches to the determination of those laws.

(79.) Some compensation is, however, afforded us, while struggling with the obstacles which impede our progress in the direct and thorny path of science, by the abundant resources accessible to us in the psychological considerations, which every where arise in this vast field of contemplation. All the phenomena of organic beings reveal to us so palpably the indications of *design*, that we cannot resist the impression thus created in our minds; nor can we avoid recognising the connexions which are so established between the objects and the changes they present, as being those of means employed for the accomplishment of certain ends. Thus, then, the relation of means to ends becomes a leading principle of association among the facts of physiology; giving a new aspect to the science, and creating an interest of a different and much higher kind, than could ever be inspired by the study of mere physical relations. So deep has been this impression, and so completely has the principle of final causes been interwoven with the pursuits of physiologists, that the study of the *functions of life*, that is, of the purposes to which the actions constituting life are subservient, has been almost universally regarded as the principal, if not the sole object of the science. It has, accordingly, been assumed as the basis of arrangement, in all systematic treatises of Physiology; and likewise in framing theories for explaining the phenomena of life, physiologists have generally been satisfied with pointing out their final, rather than their physical causes.

(80.) This natural proneness to substitute final for physical causes has been a frequent source of delusion, by insensibly leading to the belief that we have reached the physical law which regulates the phenomena we are viewing, when we have, in fact, done nothing more than traced their relation to the intelligent agency by which they have been each adjusted to their respective objects, and given that law a name with reference to that agency; thus, in our eagerness to grasp at hidden knowledge, mistaking the shadow for the substance.

Ancient divisions of the subject.

(81.) Frequent instances of this confusion of ideas occur in the writings of the older physiologists; but at all times the predominant tendency has been to refer the phenomena to their final causes; that is, to the purposes which they answer in the animal economy. The functions were arranged by the ancients into three classes, designated by the titles of *animal, vital*, and *natural;* the first comprising those powers of sensation and of voluntary motion which are more especially characteristic of animal, as contradistinguished from vegetable life; the second, those powers, the continued exercise of which are immediately necessary for the maintenance of life, such as respiration of the blood; and the third, those which are directly concerned in the continuance of its vital actions, but which are yet indispensable in preserving the organs in the conditions enabling them to perform their respective offices, by supplying the materials requisite for their nutrition, and for counteracting their tendency to decomposition; in this class were included digestion, secretion, and absorption. To these were added by many, a fourth class, the *generative*, comprehending all the functions which have for their object the continuance of the species by the reproduction of individuals similar to the parent animal. The principal objection to this arbitrary division of the functions is, that the line cannot be drawn with sufficient distinctness between what are called the vital and the natural functions, their connexion with the maintenance of life being one of degree only, and not of kind; as is evident from their being united together in the lowest tribes of the animal kingdom. This classification appears also to be defective, inasmuch as it omits all notice of those functions which have immediate reference to the mechanical condition of the frame; conditions which are the foundation of their physical capabilities of executing the operations assigned them in their respective places in the general system. It is also liable to the imputation of employing terms to designate the classes which are obviously incorrect, and bear not the meaning they are intended to convey. In one sense, and that which would first present itself to the mind, the term *animal* functions would comprehend all the others, for there are none in which powers peculiar to animal life are not called into play; and, on the other hand, the strictly animal functions are equally entitled to the appellation of *vital*, as being directly essential to the support of life; and no specific meaning can attach to the term *natural*, as applied to any description of functions.

Classification of Vicq D'Azyr.

(82.) Vicq D'Azyr proposes to establish a preliminary division of the functions into two great classes; the first, comprising those concerned in the preservation of the individual; and the second, those concerned in the preservation of the species. The former class he divides into two orders; the first having for their object the assimilation of food into the substance of the body, and designated as the interior assimilative and nutritive functions; and the second, establishing the relations of the individual to surrounding objects, and denominated the exterior or relative functions.

The first of these orders comprises six genera; namely, 1st, *digestion*, by which the nutritive particles are extracted from the food; 2d, *absorption*, by which this nutritive matter is conveyed into the blood; 3d, *circulation*, by which it is carried to all the organs; 4th, *respiration*, by which it is exposed to the influence of atmospheric air; 5th, *secretion*, by which it is made to undergo various modifications; 6th, *nutrition*, by which it is applied to the organs for the purposes of growth and nourishment.

The second order of the first class comprehends three genera; namely, 1st, the *sensations*, which give to the individual notice of the presence of surrounding objects; 2d, the *motions*, which bring him towards, or remove him from them; 3d, *voice* and *speech*, which enable him to communicate with his fellows without transporting his body to a different place.

The second class, or the generative functions, likewise comprise two orders; the first, including the functions of *conception* and *generation*, requiring the concourse of both sexes; the second, including *gestation, parturition*, and *lactation*, performed exclusively by the female. To these were subjoined by Vicq d'Azyr, as a kind of supplement to his system, the several facts relating to the progressive changes taking place during the advance of life from infancy to decrepitude, through the ages of growth, of maturity, and of decay, and to those which attend the absolute extinction of life, and the subsequent decomposition of the organs.

The arrangement of Vicq d'Azyr is entitled to much commendation, and has been followed in all its essential features by Dumas,[1] Richerand,[2] and other systematic authors on physiology, with the exception of Haller,[3] who adopted a classification of functions founded altogether on the anatomical relations of the organs by which they are performed.

Of Bich and Dumas.

(83.) Bichat,[4] whose original genius led him to disregard the opinions of his predecessors, and to strike out for himself new paths of inquiry, aimed at giving greater simplicity to physiological classification, by pursuing a more rigid analysis, and infusing a more philosophical spirit into the methods of research. With this view he distributed the functions into two classes, which he denominates respectively the *animal* and the *organic*; the former coinciding nearly with those already known by that title; and the latter comprehending both the vital and the natural functions of preceding writers. Impressed, however, with the necessity of drawing distinctions among the powers of life, he has perplexed his system by intermixing with those final causes, which he takes as the basis of his divisions, the results of a philosophical analysis of those powers. He is thus led to make continual efforts to establish a distinction between muscular contractibility, which is one of the simple and elementary powers of life, when that power is employed in subservience to the animal functions, and when it is subservient to the functions of organic life; a distinction which regards only the final, and not the physical causes of the phenomena. Dumas[5] has been guilty of a still more palpable error in deeming it necessary to add to his catalogue of principles, consisting of the acknowledged powers of sensibility and contractility, a third power, which he terms "*the force of vital resistance*;" thus associating a final cause in the same rank with causes that are strictly physical.

Of Cuvie Adelon, Bourdon, and Béclard.

(84.) To the animal and vital functions of Bichat, Cuvier has added, in his physiological arrangement, a third class, the *generative*, which cannot, indeed, be, with any propriety, included in any of the former. He still, however, falls into a similar mistake as that of Dumas, which we have just now pointed out; for he describes sensibility and muscular contractility not as primary principles, but both of them functions of the nerves. Adelon[6] distinguishes the following eleven actions as being the functions of life; namely, *sensibility, locomotion, language, digestion, absorption, respiration, circulation, calorification, secretion*, and *generation*. Bourdon[7] reduces them to seven, which are as follows: *caloricité, nutrivité, absorptivité, exhalativité, durabilité, reproductivité*, et *resistabilité;* thus presenting a strange jumble between physical principles of action, and actions referred to definite purposes. The same confusion may be remarked in the classification of the functions by Béclard,[8] who has arranged them into six classes, viz. *nutrition* in its most extended sense, *generation, muscular action, sensation, nervous action*, and the functions of the *intellect*. But it would be needless to multiply examples of this error, since it will be found to pervade almost every physiological system that has yet been framed, not excepting even that adopted by Dr. Bostock, in his valuable *Elementary System of Physiology*.

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[1] *Principes de Physiologie.* [2] *Elémens de Physiologie.* [3] *Primæ Lineæ Physiologiæ.* [4] *Anatomie Générale.* [5] *Principes de Physiologie.* [6] *Physiologie de l'Homme.* [7] *Principes de Physiologie Médicale.* [8] *Elémens d'Anatomie.*

Bostock. (85.) Dr. Bostock regards contractility and sensibility as the two primary attributes of animal life, each equally characteristic of it, and peculiar to it, and each performed by its appropriate organs. " The functions," he remarks, " depend on the exercise of these powers, and although probably, in all cases, they are both of them exercised, yet generally one of them seems to be the principal agent, or the prime cause of the ensuing operation ; we may consequently divide them into the contractile and sensitive functions, or those which more directly belong to contractility and to sensibility, and which, of course, serve respectively for motion and sensation, and to these two classes must be added a third class of the intellectual functions." Among the contractile functions, the essence of which consists in motion, Dr. Bostock considers the circulation as being the first in point of importance, and the one which may be regarded as the most necessary to the direct support of life, and to the indirect maintenance of all the rest. Next in importance is respiration, which modifies the blood so as to adapt it to the maintenance of life. After these two functions, by the former of which the blood is carried to all the parts of the body, and by the latter of which it acquires its vital properties, Dr. Bostock places those of calorification, secretion, digestion, including assimilation and sanguification, and absorption, functions which contribute, he observes, to the continuance of the motion of the animal machine, and which preserve all its parts in their proper condition, without, however, being essential to the immediate support of life. In this class he places the function of generation, which, although one of the most inexplicable of all the operations that are performed by the animal powers, and acting in a specific manner of which we have no other example, may be considered as essentially consisting in secretion.

The sensitive functions are divided by Dr. Bostock into two classes ; first, those which originate in the action of the external agents on the nervous system ; and, secondly, those of a reverse kind, which depend on the reaction of the nervous system on these agents. In the first of these divisions are included what are called the external senses, the sight, hearing, taste, smell, and touch ; and in the same division must be placed the sensation of hunger, that of temperature, and some others, which have not been correctly discriminated from general feeling, but which possess specific characters. In the second class, those functions which depend on the reaction of the nervous system on external bodies, he places volition ; and to the same class he also refers instinct, association, sympathy, habit, and some other faculties of a similar kind, which appear to hold an intermediate rank between the corporeal actions and those of a purely intellectual nature. As the functions which compose the first of these classes may be all referred to a species of perception, so the latter may be considered as more or less analogous to volition ; in the former, the effect on the nervous system, whatever it may be, is propagated from the extremities to the centre ; in the latter, it proceeds in the opposite direction, from the centre to the extremities of the body.

The intellectual functions compose, in this arrangement, the third class. These, Dr. Bostock observes, are a less direct object of physiology than the two former, yet many of them are so closely connected with the physical changes of the body as to require being included in a complete view of the animal economy. Among those intellectual operations which possess a decided action on the corporeal frame, he places the *passions ;* and also refers to this class tha compound of mental and physical influence, from which results what are called *temperament* and *character*. These lead to the consideration of functions of a more purely intellectual kind, which, as they recede from the corporeal, and advance towards the mental part of our frame, are less within the province of the physiologist, and belong more to the metaphysician or the moralist.

(86.) Dr. Alison[1] has adopted a principle of arrangement, which, though differing in some of its applications, is essentially the same as that of Dr. Bostock, as it is derived from the analysis of the phenomena of life into certain powers ; or, if these phenomena be considered as the results of a single principle, which we may denominate *vitality*, the study of physiology will resolve itself into an inquiry into the conditions under which the various phenomena of life take place, that is, into the *laws of vitality*. These laws are ranked by Dr. Alison under three heads : 1. Those of *vital contractions*, by which the visible movements of living animals are chiefly effected : 2. Those of *vital affinities*, by which the chemical changes peculiar to living animals are determined, and their physical structure maintained : 3. Those of *nervous actions*, by which the physical changes in living animals are placed in connexion with mental phenomena, and subjected to the control of mental acts. The first and third of these divisions correspond to those of Dr. Bostock, which he has denominated the contractile and the sensitive functions. The second division of Dr. Alison is founded on the principle pointed out by the writer of the present article, in a treatise on Physiology which appeared many years ago in the last Supplement to this work, and to which he gave the designation of *the organic affinities*. Of Alison.

Dr. Alison considers that the movement of the fluids, in all the higher classes of animals, is in a great measure dependent on vital contractions in certain of their solids, and may accordingly be regarded as the first and most important consequence of the exercise of the vital power. This subject he divides into two parts ; first, the movement of the mass of blood in the heart, arteries, and veins, or the function of circulation ; and, secondly, the continual evolution of matters from, and absorption of matters into, the mass of blood ; or the functions of nutrition, exhalation, secretion, and absorption, to which the circulation is subservient, and on which all the other functions are dependent. The study of these nutritive functions naturally introduce the consideration of the properties of the different textures and secretions which are formed from the blood, and which are the materials combined in the construction of the organs themselves.

The nervous system has been endowed with peculiar properties or powers, in order that it may be the seat, and the instrument, of mental acts. These mental acts, and all the functions in which they bear a necessary share, constitute, according to Dr. Alison, the animal life, or animal functions. As in all animals the reception of food into the digestive organs, and in all vertebrated animals, and many of the inferior orders, in the adult, the reception of air into the respiratory organs is accomplished by movements which are excited through the intervention of sensations and of instincts and volitions ; he considers the commencement of the processes of respiration and digestion in them as belonging to the province of animal life, and as dependent on the nervous system. Dr. Alison, therefore, commences his account of the animal functions, with the consideration of respiration, animal heat, and digestion, which he refers to that class: proceeding afterwards to notice the physiology of the external senses, of the mental faculties, voluntary and instinctive motion, the involuntary action of the mind on the body, sleep and the analogous states of somnambulism, reverie, and other irregular actions of the nervous functions. The subjects of generation, and the peculiarities of age, sex, and temperament, occupy the concluding chapters of his work.

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[1] *Outlines of Physiology and Pathology*, Edinburgh, 1833.

Of Mayo. (87.) The order in which Mr. Mayo has treated of the functions,[1] differs but little from that adopted by Dr. Alison.

Of Roget. (88.) The author of this article has given, in his *Bridgewater Treatise*,[2] an arrangement of the functions founded altogether on the basis of final causes: and corresponding therefore with the views, which have been explained in the preceding chapter, of the relative subordination of purposes which the functions are designed to answer in the economy; and not limited to human physiology, but embracing all the different forms and modifications which those functions present in the animal kingdom. Taking them in the order of their increasing complexity, he has distributed them into the four following classes; namely, first, *the mechanical functions*, which include the consideration of all the circumstances relating to the mechanism of the frame and of its different organs; the arrangements provided for procuring the proper cohesion, strength and mobility requisite for the different actions they have to perform; and also for the preservation of their connexions, support, security and other mechanical conditions adapted to the exercise of their respective functions. To this head are also referred the operation of the moving powers, derived principally from muscular contractility, by which the various parts of this system of machinery are set in motion.

Secondly, the *nutritive*, or *chemical functions*, corresponding to what has been formerly denominated the vital functions; and the object of which is the preservation of the organs in those states of chemical composition which enable them to sustain life, and to perform their destined offices in the economy. The functions by which, in the higher orders of animals, this object is accomplished, may be arranged under the following heads; each, however, admitting of further subdivision. 1. *Assimilation*, including the processes which prepare the food for *digestion*, *chymification*, which is the office of the stomach, and *chylification*, which is performed in the intestines. 2. *Lacteal absorption*, by which the chyle so prepared, is collected into the heart and blood-vessels. 3. *Circulation*, by which the blood, or nutrient fluid, is regularly diffused over the system. 4. *Respiration*, or the aeration of the blood. 5. *Secretion*, by which the properties of that fluid are modified. 6. *Excretion*, by which various chemical principles are separated from the blood, and discharged from the system. 7. *Absorption*, by which substances are conveyed from different parts back again into the general mass of circulating fluids. 8. *Nutrition*, by which the nutritive matter is applied to the growth or restoration of the various organs of the body, so as to maintain them in the state which enables them to discharge their proper functions. 9. For effecting all these various processes, the agency of a peculiar power, derived from the properties of the nervous system, is requisite. This may be termed the *nervous power*, in contradistinction to those actions of the same system, which have reference to mental phenomena, and which come under the next class of functions.

Thirdly, the *sensorial functions* comprehends all those corporeal changes in which the mind is concerned; and consequently include those of *sensation*, of *perception*, of *volition*, and all those intellectual functions which employ for their agency the physical organization of the body.

Fourthly, the *reproductive functions*, which have for their object the continuance of the species, and the multiplication of its numbers. This subject is naturally connected with the progressive developement of the organs, the growth of the body from infancy to manhood; and the stages of its decline, till all the vital phenomena cease by the death of the individual.

CHAPTER IV.—THE VITAL POWERS.

Physic laws. (89.) We have already remarked, that there are two ways in which the assemblage of phenomena presented to us by living beings may be studied. We may, in the first place, view these as mere physical phenomena, applying to them the same methods of induction which have been employed with so much success in other departments of natural science. The object of philosophical induction is the reference of the events occurring in nature to their proper causes. This is accomplished by comparing the phenomena together, observing in what they agree, and in what they differ, classing them in the order of their agreement; and distinguishing them according to their differences. The result of this process, when it has been carried as far as the extent of our mass of facts will allow, is the establishment of certain general relations between these facts, or conditions, under which they occur, and which we may consider as so many *laws of nature:* and any appearance we may afterwards meet with which corresponds in its character to any single law, or combination of these laws, is at once referred to them, and considered as a particular instance or exemplification of these laws. When we can succeed in tracing these coincidences with a previously established law or general fact, we are said to have discovered its cause. Philosophy, in this sense, then, comprehends the collection and comparison of phenomena, their classification, the establishment by careful induction of general laws; the verification of these laws by experiment; and lastly, the subsequent reference of particular phenomena to their appropriate laws.

(90.) In the sciences which relate to the laws of matter in its inorganic state, this inductive method of philosophising admits of being pursued to an indefinite extent, and with comparative facility. The phenomenon themselves, which are the subjects of induction, are of a simple and more definite character than those of animal or vegetable life; they are generally more under our control; and more easily subjected to the test of experiment. The endless variety of the forms of life, the extent and intricacy of the connexions between the different parts of the animal system, introduce a degree of complexity in the phenomena, incomparably greater than is ever met with in the combinations of inorganic matter. We shall accordingly find that the knowledge we have hitherto acquired of the physical laws which govern the vital phenomena, is as yet exceedingly imperfect.

Propert of inorg- ic matt (91.) In entering upon the philosophical study of the phenomena presented to us in the living body, and carefully arranging them according to the rules of induction, and without reference to the final causes that connect them, (a subject which forms a totally different branch of inquiry,) we easily recognize the operation of many of those powers and principles to which inorganic matter is also subjected. The living system, with all its complicated apparatus of solids and fluids, is obedient to the universal laws of gravitation, of cohesion, of elasticity, of capillary attraction, &c., as well as to the ordinary principles of mechanics, hydrostatics, hydraulics, and pneumatics, which result from combinations of these laws; and we may pursue the application of these laws to the mechanism of the body, as far as no other causes intervene, without danger of error.

Vital p perties. (92.) The laws of chemistry apply also, to a certain extent, to the changes which are going on in the living system; but in tracing the operation of these laws, we soon become sensible of the apparent interference of other principles which seem to control the ordinary chemical affinities which the same kinds of matter are found to exert when deprived of life. Here, then, we perceive a sensible deviation from the course of phenomena exhibited by inorganic matter; and we are forced to recognize the existence of new and unknown powers peculiar to, and characterizing the living state. We discern the operation of such powers in the processes of digestion, of sanguification, of nutrition, of secretion, of the growth and organization of the various structures that compose the fibres of the body. Powers of a similar kind are exhibited in the phenomena of vegetation: they seem, therefore, to attach to vitality in all its forms. In order to distinguish them from the ordinary chemical affinities to which they are so frequently opposed, we shall designate them by the name of *Organic Affinities*, although, as we shall afterwards attempt to shew, they probably do not differ in their kind, but only in the circumstances and conditions of action, from the ordinary inorganic affinities.

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[1] *Outlines of Human Physiology*, 3d edition, London, 1833.

[2] Roget, *Animal and Vegetable Physiology, considered with reference to Natural Theology*, two vols. London, 1834.

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(93.) Another power which more peculiarly appertains to animal life is *Contractility*. This is especially a property of those fibres which compose the muscles. It is often denominated *Irritability*, a name originally given to it by Glisson, but which has justly been objected to by Dr. Bostock as a term employed in many different senses, according as it is applied in physiology, pathology, or ethics. Haller speaks of it frequently under the designation of the *Vis insita*. The term *Contractility*, adopted by Dr. Bostock,[1] and sanctioned by many other eminent physiologists, is in itself unobjectionable, and has the advantage of being a simple expression of the fact itself. It consists in the spontaneous shortening of muscular fibres, in consequence of the impression of certain agents termed *stimuli*, by a power residing in the fibres themselves, and which operates with a force greatly superior to any of the ordinary mechanical sources of motion.

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(94.) The remarkable property which the nerves possess of conveying with electric celerity impressions made on one of their extremities, or even on any part of them, to the opposite extremity, and to other parts in the line of their course, the influence of which impressions are rendered apparent by certain effects, such as the contraction of the muscles, increased or modified action of the blood-vessels, absorbents, and organs of secretion, and the evolution of animal heat. All these effects may take place from impressions, or *irritations*, (by which term is meant impressions of a certain degree of intensity,) which do not excite sensation, or volition, or any other mental change; and they even occur after the destruction or removal of those parts of the nervous system which are connected with affections of the mind. A power of the same kind is also possessed by those nerves which are connected with the sensorium, on the parts in immediate connexion with the sentient principle.

(95.) It is by the exertion of this power that impressions made on those nervous filaments which are instrumental in sensation, and especially if made on their extremities which are distributed to the organs of the external senses, are instantly transmitted to the sensorium, in which they may be said to terminate, and the changes produced in which are attended by the mental affection termed *sensation*. In like manner, certain other changes in the sensorium, consequent on *volition*, which is a mental affection, are followed by the contraction of certain muscles, by means of some unknown influence communicated through the medium of certain other nervous filaments having their origin in the sensorium, and their termination in those muscles. The nature of the power by which these transmissions are effected in the course of each of these sets of nervous filaments, judging from the similarity of the circumstances under which it takes place, especially in the instantaneousness of the effect, is probably the same in every case; the only perceptible difference in the mode in which it is exerted consisting in the direction of the transmission. This remarkable power, which is totally distinct from any mental effect that may accompany its exertion, we shall distinguish by the name of the *nervous power*.

Sensorial
power.

(96.) A fourth power, perfectly distinct from any of the former, although it also belongs to a portion of the nervous system, is that from which the corporeal changes which take place in those parts immediately connected with sensation, volition, and the intellectual operations, proceed. To this specific property, which should be carefully distinguished from the mere faculty of transmission possessed by the fibres of the nerves, the name of *sensorial power* has been given. We are indebted to Dr. Wilson Philip for the establishment of this important distinction in the specific powers of the nervous system, and for having bestowed upon it the above appropriate designation. The same term had, indeed, been employed by physiologists in a different and much more extended sense, as including muscular irritability, which had been regarded as in some way or other analogous to nervous power. In the sense in which we shall use the term, it is meant to apply exclusively to those physiological changes occurring in certain parts of the nervous system, which produce or accompany changes or affections of the mind.

(97.) It is evident that the astonishing properties belonging to the refined organization of the brain, which constitute sensorial power, and which are, in a manner utterly incomprehensible to us, connected with the affections of the sentient and intelligent principle, present subjects of far higher interest than even the organic, muscular, or nervous powers, and are infinitely more remote from the ordinary attributes of matter.

Gradation
of powers.

(98.) Thus we may perceive that the system of the living body exhibits not only a multiplicity of new powers, which we no where meet with in unorganized matter, but also presents us with a gradation of powers ascending from those of a mechanical nature, but yet derived from highly artificial arrangement of particles, to those of a refined and elaborate chemistry silently at work in the secret laboratories of the body; rising again to principles of a still more elevated order, acting through the medium of the nerves; till we lose ourselves in the more lofty contemplation of those mysterious agencies, which confer on the central portions of the nervous system the power of exciting sensation; which render them instruments of thought and of volition, and which stamp on the being they compose the distinctive character of individuality.

(99.) Viewed with reference to their subserviency to final causes, it is to the sensorial powers, which confer the capacity of enjoyment, that the supreme rank in point of importance must be assigned. The faculties of sensation, of voluntary motion, and of enjoyment, are the only ultimate ends for which, as far as we can judge, the animal has been created and endowed with life. Those ultimate ends of its being are attained primarily by the sensorial powers; and to the maintenance of these are the muscular and the nervous powers subservient. Of these latter powers it is also evident that the muscular is placed in obedience to the nervous, in the same manner as the nervous is obedient to the sensorial power. Thus, the views now presented of the classification and distribution of the physical powers which operate in producing the phenomena of life, are in strict accordance and harmony with the results obtained from the consideration of final causes, which we have already presented in our preliminary chapter.

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[1] *Elementary System of Physiology*, third edition, pp. 91, 92.

Vital principle.

(100.) If the analysis we have here offered of the vital powers, that is, of powers peculiar to the phenomena of life, and the distinctions we have endeavoured to establish between them be correct, we shall be enabled at once to detect the fallacy of those views of life, and of those definitions of the vital principle which are generally received; and which, we apprehend, have been laid down in violation of the just rules of philosophical induction. The truth is, disguise it how we may by a vain parade of words, that the real state of the science is not sufficiently advanced to authorise that degree of generalization which these definitions would imply. We are certainly not warranted, by the phenomena already known, in regarding life as the effect of any *single* power. The attempt of *Brown*, of *Hunter*, and of *Bichat* to reduce the science to this state of simplification, though highly ingenious, are yet premature; and have, it is to be feared, had rather the effect of retarding than of advancing the progress of real science.

Archæus.

(101.) Many of the older physiologists entertained the notion of a principle, endowed with qualities in some measure partaking of intelligence, and as if it were a spirit presiding over and governing the vital actions. Such was the idea attached by Van Halmont, and by Stahl, to the principle which they termed the *archæus*, or *anima*, and which they conceived regulated the operations of the different powers of the system; an assumption which, however naturally suggesting itself to the mind, while contemplating the harmonious adjustments that pervade every part of the animal economy, is in no respect a philosophical explanation of the phenomena, and is even utterly irreconcileable with some of these phenomena. In like manner, the *vis medicatrix naturæ*, which Hoffman and Cullen have so largely employed in their pathological theories, and which supplied them with ready solutions of every obscure morbid change that embarrassed them, was, in fact, nothing more than a branch of the same doctrine. Nor have the more sober theorists of modern times been sufficiently on their guard against this illusion. In the attributes which John Hunter ascribes to his *vital principle*, we may continually trace the same want of discrimination between that intelligence, by which the conditions of organization were originally adjusted to a variety of contingent circumstances, and those physical agents, by the instrumentality of which the intended objects are attained. When it is said, for example, in the language of this school, that the coagulation of the blood is occasioned by "the stimulus of necessity," it is clearly the final cause alone which is indicated, while the real physical cause is not assigned; and it is also evident that no advance is thereby made towards its discovery. This *principle of life*, with which organized beings are endowed, is represented as a new power, which modifies and controls the operation of those simpler physical laws, to which the same matter, in its unorganized state, is subjected; a power which imposes new cohesive and repulsive forces on the solid materials of the animal or vegetable structures, which imparts to the fluids a new property of coagulation, which alters the order of chemical affinities between their elements or primary compounds, retaining them, contrary to their natural tendencies, in a certain state of equilibrium, and resisting the agency of causes usually tending to destroy that state: and, lastly, which produces, in a degree corresponding with the wants of the system, either an evolution or an absorption of caloric. All these, it must be admitted, are purposes of manifest utility, being directly conducive to the welfare of the individual, and indeed essential to its continuance in the living state. In as far as they are means conducive to specific ends, the reference of all these phenomena to one class cannot be objected to. The fallacy lies in regarding it as a philosophical generalization of effects of a similar kind, resulting from the operation of a simple power in nature; for between many of these effects, considered as mere physical phenomena, there exists not the remotest similarity. But it is the fundamental principle of the method of induction, that similar effects alone are to be ascribed to the agency of the same physical cause. Judging, therefore, from the observed effects, which differ widely in their nature from each other, we ought to infer the operation of several distinct powers, the concurrence of which is requisite to produce the complex phenomena in question. We are, no doubt, unavoidably led to view these phenomena as conjoined, because we witness their existing combinations, and perceive that they are tending to the accomplishment of a specific purpose; namely, the preservation and welfare of the being to which they relate. But this unity of design is an attribute, not of matter, but of intellect, and does not necessarily imply the unity of the agent employed in their production.

(102.) We may take as an example, the phenomena of the circulation of the blood, which, when viewed with relation to that function, form together so beautiful and harmonious a system. These phenomena, taken abstractedly, are ultimately resolvable into such as result from a few general powers, as muscular contractility, membranous elasticity, the hydraulic properties of the blood, &c. The phenomena of digestion, in like manner, when subjected to analysis, are found to be results of the combined agencies of the muscular action of the stomach and intestines, of the chemical powers of the gastric juice, the bile, &c. of the organic powers of secretion, and so forth; all of which concur in the production of a definite object, namely, the conversion of the aliment into chyle. The combined processes subservient to this purpose, constitute, when viewed in their relation to final causes, the function of digestion.

Identity f vital w physica forces.

(103.) However the laws which regulate the vital phenomena may appear, on a superficial view, to differ from those by which the physical changes taking place in inorganic matter are governed, still a more profound investigation of their real character will shew that, when viewed abstractly from the consideration of final causes, there is really no essential difference between them, either as to their comprehensiveness, their uniformity of action, or the mode in which they are to be established by the generalization of particular facts.[1] The difficulty of effecting these inductive generalizations is undoubtedly incomparably greater in the former than in the latter; but this difficulty is similar to that which impedes our progress in all cases where the existing combinations which are the objects of study, are too numerous and too complicated to yield to our powers of analysis. We have examples of this difficulty in many branches of physical science; in meteorology, for example, where no one can doubt that the phenomena are the results of the ordinary physical powers, of the laws of which we are tolerably cognisant; but the operations of which, in effecting the daily and hourly changes of atmospheric phenomena, have hitherto baffled the most persevering and penetrating inquiries directed to this highly important branch of physics. There is, in like manner, no distinct evidence of the material particles, which compose the organized and living fabric, being actuated by any powers or principles different from those which are inherent in them, in their ordinary or inanimate state. They are, in both cases, obedient to certain definite physical laws, the operation of which is determined by the peculiar circumstances of their mode of combination, and the peculiar conditions under which they are brought into action.

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[1] See an Essay by Mr. Carpenter on the difference of the Laws regulating Vital and Physical Phenomena, Edinburgh New Philosophical Journal, xxiv. 327.

(104.) It may, in like manner, be contended, that the affinities which hold together the elements of living bodies, and which govern the elaboration of organic products, are the same with those which preside over inorganic compounds; and that the designations of *organic* and *vital affinities* are expressive only of peculiarities attending the circumstances and conditions under which they are placed, but do not imply any real difference in the nature of the powers themselves. If our knowledge of these circumstances and conditions were complete, their identity would be at once revealed to us; but until that period, which must be very far distant, has arrived, we must be content with gathering a few indications, which occasionally break out from the clouds of mystery in which the subject is obscured, of the similarity of operation between these two apparently contending powers, the ordinary chemical, and the extraordinary vital affinities. Every fresh discovery in animal and vegetable chemistry, by shewing the mutual convertibility of many of the proximate principles of organic compounds, adds to the number of those indications. Hence it becomes every day more and more probable that the forces immediately concerned in the production of chemical changes in the body, are the same as those which are in constant operation in the inorganic world; and that we are not warranted in the assertion that the operations of vital chemistry are directed by distinct laws, and are the results of new agencies.

(105.) We are therefore led to the conclusion, that the vital properties are not, as it is commonly expressed, superadded to matter in the process of organization, but are the result of the material constitution, that is, of the peculiar combinations and arrangement of the ultimate molecules of the organized tissues, which call out and develope the properties previously existing in those molecules, but which cannot be effective unless these circumstances exist.

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(106.) However natural it may be to conceive the existence of a single and presiding principle of *vitality*, we should recollect that this, in the present state of our knowledge, is only a fiction of the mind, not warranted by the phenomena themselves, in which we perceive so much real diversity, and therefore inadmissible as the result of a philosophical induction. We find that vitality ceases in different textures, at different periods, prior to the total extinction of life; a phenomenon which appears scarcely compatible with the unity of any such power.

(107.) It is well known that attempts have in like manner, from time to time, been made to reduce the phenomena of the inorganic world, to a single primordial law; instead of being content to refer them to the operation of distinct laws, such as those of gravitation, cohesion, elasticity, light, heat, electricity, magnetism, and chemical affinity. The phenomena usually ascribed to these great powers of nature have, for instance, been considered as resolvable into one universal principle of *attraction*. By other philosophers, they have been regarded as the effects of a general and sole power of *repulsion*. None of these simplifications are as yet warranted by facts; and equally vain, in the present state of the science, is the endeavour to reduce all the vital phenomena to one single law. It is possible, or perhaps even probable, that future researches may be successful in establishing the identity of some of the powers we now conceive to be distinct, with other powers already known. Thus, in the physical sciences, the recent discoveries that have taken place in electro-magnetism, have satisfactorily established the identity of the magnetic and electric agencies. The same may possibly be accomplished in future times, with regard to heat and light, which are already connected together by so many analogies. But no such approximation can yet be attempted with any prospect of success, between the muscular, the nervous, the sensorial, and the organic powers. No speculative ingenuity can reduce them to a single physical power; nor can we establish any kind of association between them, but by the consideration of another and a totally different class of relations, namely, those they bear to the general object which they combine to produce. This, however, is to substitute final for physical causes; a mode of procedure which we have seen, is totally at variance with the principles of philosophical induction. It is physical causes only which are the legitimate objects of philosophical analysis, and the true bases of the physical sciences.

Order in which the functions will be considered.

(108.) We shall now proceed to give an account of each separate function; taking them in the order of their respective simplicity, with reference not only to their objects, but also to the powers which are concerned in their accomplishment.

We shall accordingly begin with the consideration of the *mechanical functions*, as being more simple in their character, and implying the operation of the simpler powers of organization; together with the peculiar faculty of muscular contractility, which is the great source of mechanical power provided for carrying on the greater movements of the machine. We shall, in the second place, review that class of functions which depend more especially on the operation of the *organic affinities*, and which have for their objects the nutrition and extension of the organs, and their maintenance in that state of chemical, as well as mechanical condition, which fit them for the performance of their respective offices. We shall then be properly prepared for the study of that higher class of functions, which appertain to *sensation*, and all the other faculties connected with mind; functions which imply, in addition to all the powers concerned in the preceding functions, others of a superior order, but which, although in the highest degree interesting and important, are incomparably the most obscure and complex of all. Our attention will, in the last place, be directed to the functions relating to *reproduction*, the study of which requires a previous knowledge of every other department of physiology.

CHAP. V.—THE MECHANICAL FUNCTIONS.

Sect. I.—*On Organization in general.*

Idea of organization.

(110.) If we analyze the ideas attached to the term *organization*, we find that it implies, as its essential condition, a specific arrangement of parts, adapted to some particular purpose, and composing by their assemblage, an individual system endowed with life. It seems impossible, therefore, to attach the idea of organization to a mere fluid, because the mechanical condition of the particles of a fluid is such as to preclude the capability of any permanent arrangement. It appears to be essential to every organized structure, that there shall be solid parts provided for containing those which are fluid. All animal bodies accordingly, are composed of solids and fluids; the former being more permanent in their nature and arrangement, and constituting the basis by which the general form of the body is determined; and the latter, being lodged in appropriate cavities formed by the solids, but capable by their mobility of undergoing more rapid changes of place, and of chemical composition.

(111.) It may in general be said, that the solids bear but a small proportion to the fluids, which enter into the composition of the body. It is difficult, however, to determine the exact proportion which they bear to one another; in the first place, because this proportion is not fixed, and admits of variation in different ages, circumstances, and conditions of the system; and secondly, because it is scarcely possible to effect the complete separation of these two constituent portions; partly from the ready conversion of the solids into fluids, and *vice versa*, and partly from the tenacity of their mutual adhesion. Some estimate of this proportion has been attempted to be formed, by carefully drying the dead body in a stove, or oven; and the result of some experiments has been, that in an adult man, the weight of the fluids is to that of the solids, as six to one, or, according to other experiments, as nine to one. From the examination of an adult Egyptian mummy, which may be supposed to contain nothing but the dry fibres of the body, a still lower proportion has been assigned to the solid part; since this mummy weighed only seven pounds and a half.[1]

Is there an elementary material?

(112.) The possibility of reducing all the organic textures of the human body to one elementary material, which might be regarded as the basis of the whole, was long a favourite subject of speculation among anatomists: and Haller has devoted to it the first section of his great work on Physiology.[2] He conceives that all the solid parts of the frame are ultimately composed of fibres; the animal fibre being the simplest form of organized matter, and being to the physiologist, what the line is to the geometrician, that from which all other figures are produced. This simple fibre, he observes, is invisible, even with the assistance of the microscope; it is only by the union of the primary fibres, that visible fibres are constituted; and from the assemblage and lateral adhesion of these, again, thin plates of animal substance are formed, while the grosser substance of the organs themselves, is composed of a complicated contexture of these plates and fibres. This supposed basis, or essential constituent, of all animal textures, has been by some termed the *animal parenchyma*, and by others, has been designated by the general name of *animal membrane*.

Theory of universal vascularity.

(113.) Besides this spongy or areolated texture, which composes by far the greater bulk of the organs of the body, Haller has also admitted two other constituent parts, namely the *muscular*, and the *nervous substances*. These views have since been generally adopted by physiologists, with some slight modifications. Many have thought it necessary to introduce, in addition to the preceding, an element which they consider as of a tubular form, constituting vessels fitted to contain fluids. This was the favourite doctrine of Boerhaave, who supposed that the simple fibres, or the smallest into which they can be conceived to be divisible, formed by their lateral adhesion, a membrane of the first order, which, when coiled up into a tube, would constitute a vessel of the first order. These vessels, again, when interwoven together, composed a new order of membranes, by the duplication of which a second order of vessels was formed. Successive series of membranes and vessels were thus constructed, until they acquired a magnitude sufficient to be visible to the eye. According to this hypothesis, therefore, all the parts of the body might ultimately be resolved into a congeries of vessels, arranged in these ascending orders. This hypothesis, which evidently rested on the most visionary basis, has been ably refuted by Albinus, and by Haller. It has, however, left some traces in the opinions expressed by many subsequent anatomists, who still cherished the idea of the universal vascularity of the animal fabric, and of this vascularity being essential to organization. The skilful injections of Ruysch, who succeeded in introducing coloured fluids into vessels, the contents of which are naturally transparent, had long ago shown that there exists an order of vessels too minute to be otherwise detected. Dr. William Hunter has, even in later times, adopted the opinion that every living part is necessarily vascular; and that where there is no circulation, there can be no life. Mascagni was also a strenuous advocate of the hypothesis of the universal vascularity of the animal textures; but he conceived that every part is made up of a congeries of minute lymphatic vessels. We shall have occasion afterwards to point out the fallacy of these views.

Other mentar structur

(114.) Although the analysis of animal tissues, into the three primitive elements we have pointed out, namely, into the membranous, the muscular, and the nervous fibres, be founded on the most prominent and well marked features of distinction which they exhibit, yet there are perhaps other kinds of texture also, which possess sufficiently characteristic properties to entitle them to rank as elementary tissues: these are the *albugineous fibre* of Chaussier, and the *epidermoid substance;* and to these we might also add, in order to make the analysis complete, the *cartilaginous* and the *osseous structures*.

Ultima forms o tissues.

(115.) But this analysis of animal textures, has, by some later anatomists, been carried, in another point of view, still farther. With relation to the forms assumed by the elementary tissues, they have been referred to three kinds, the *fibrous*, the *lamellar*, and the *granular*, or *globular*. The two former are exemplified in the structure of the cellular substance, which composes the greatest portion of the animal fabric; the fibrous is characteristic of the muscular and ligamentous structures; the fibrous, united with the granular, is exhibited in the texture of the glands, and in the medullary substance of the nervous system; and the globular is most perfectly shown in the composition of the chyle, the blood, and several of the secretions.

Micros pical o vation. Theory Meckel Edward

(116.) Anatomists have sought for still more general results, by means of microscopical investigations. When very high magnifying powers are employed, both the muscular fibre, and the nervous or medullary matter, appear to be resolvable into a mass of globular particles, analogous to those which compose the opaque portion of the blood. Meckel has founded upon these observations the following system: He conceives that every animal structure is ultimately resolvable into two kinds of substance, the one formed into minute, but solid spherular masses, or globules; and the other, being an homogeneous, but amorphous matter, either uniting together these globules in the way of a cement interposed between them, or constituting by itself, what has been termed the cellular substance, membrane, and the various structures derived from membrane. Dr. Edwards, on the other hand, has carried this notion to the utmost possible length; for he represents the cellular and membranous substances, as being themselves composed of globules; so that, according to his views, the whole structure of an animal body will consist of globules.

Observ tions of Hodgki and Lis

But the later, and more careful investigations of Dr. Hodgkin and Mr. Lister,[3] appear to have established, that the globular appearance of the different organized textures, when viewed with microscopes of high magnifying power, is altogether an optical deception. A similar conclusion, indeed, was, many years ago, deduced by Dr. Monro, from his microscopical researches, detailed in his work on the Nervous System.

SECT. II.—*Combinations of Textures.*

System compou textures

(117.) Such being the results of the general analysis of animal textures, into a few primary elements, we are next to consider the combinations of these textures which are actually presented to us by nature, in the various organs of the body; and in order to possess the most comprehensive views on the subject, it will be proper to study these organs as forming systems of which the several parts are related to each other by similarity of composition and of properties. The most elaborate arrangement founded on this principle is that of Bichat, who distinguishes the constituent textures of the body into twenty-one different kinds.[4] But it may be objected to his classification, that it is founded on distinctions of function, as well as on those of structure. We

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[1] See Béclard, *Elémens de Anatomie Générale*, pp. 77.

[2] *Elementa Physiologiæ Corporis Humani.*

[3] *Philosophical Magazine*, and *Annals of Philosophy*, vol. ii. p. 136; and also in the appendix to their translation of Dr. Edwards' work.

[4] See his *Anatomie Générale*.

Béclard

therefore prefer following on this subject, the arrangement of Béclard, which proceeds on one uniform principle, namely, that of mechanical conformation. Taking this principle as our guide, we shall find that the systems of organs may be easily reduced to eleven different classes; namely, 1, the *Cellular;* 2, the *Adipous;* 3, the *Membranous;* 4, the *Dermoid;* 5, the *Ligamentous;* 6, the *Cartilaginous;* 7, the *Osseous;* 8, the *Muscular;* 9, the *Medullary* or *Nervous;* 10, the *Vascular;* and, 11, the *Glandular* systems of structures. The properties of these several tissues will come under our review in connexion with the functions to which they are more immediately subservient. The three first of these, however, claim our immediate attention, as being the simplest, and most generally diffused over the body.

1. *The Cellular Texture.*

cellu-
texture.

(118.) This is the simplest form in which the animal substance presents itself to our observation; and it appears to be not only the real basis of the structure of all the other organs, but also the general medium which unites their several parts together, as well as the bond of connexion between adjacent organs. It is accordingly, of all the simpler textures, that which is the most extensively diffused over the body; not only pervading the substance of the organs, but also filling up all the intervening spaces, and preserving them in their proper relative situations. Haller found it to consist of an irregular assemblage of plates and fibres, crossing one another in all manner of directions; so that when stretched or expanded by the insinuation of any fluid between the plates, the whole presents a cellular structure. These cells, which are produced by the separation of the plates from each other, are of no regular shape, but communicate freely with one another throughout the whole extent of the substance in which they are met with.

inuity
of cells.

(119.) As there is a continuity of the cellular substance in every part of the body, where it exists in this form, there must, in like manner, be a continuity in the cavities of these cells; and the consequence of this structure is, that any fluid, such as air, or water, which may happen to be introduced into any one part, will readily find its way into adjoining parts, and will thus gradually be diffused over the whole body. If the fluid be water, as happens in dropsies, it will, by its gravity, tend to accumulate in the most depending parts of the body, as the ankles, while a person is standing or sitting; and it will leave these parts, and be more generally distributed, after he has remained for some time in a horizontal posture.

The cellular texture may easily be inflated by air; and this may happen in consequence of injury, even during life; in which case the air gradually insinuates itself into every part of the frame, puffing up the skin to an extraordinary degree, so as totally to obliterate the features of the face, and disfigure the whole body. If measures be not taken to let the air escape, the patient is at length destroyed by suffocation. A remarkable instance of this disease, which is termed *Emphysema,* is given by Dr. William Hunter, in an essay on the properties of cellular texture, contained in the second volume of the *Medical Observations and Inquiries,*[1] and which also deserves particular notice, as presenting the best account of this branch of general anatomy.

Ce ar
ser y.

(120.) The cells, or rather intervals between the plates and fibres of this substance, contain in the natural and healthy state, a quantity of aqueous fluid, which has been termed the *cellular serosity,* and which serves the purpose of lubricating the surfaces of the plates, and thus, by diminishing friction, of facilitating their relative motions on each other. To this circumstance we may also trace many of the mechanical properties of the cellular texture; such as its perfect flexibility, and its great extensibility in various directions; while it exerts, at the same time, considerable powers of cohesion. The combination of these two latter properties is the source of another, which it possesses in a very eminent degree, that of *Elasticity,* or the power of recovering its original form, when the disturbing force, whether producing compression or extension, has ceased to act. It is evident that by possessing all these properties, the cellular texture is eminently qualified to fulfil the important offices assigned to it, of serving as the elastic scaffolding or canvass for sustaining all the other parts, and retaining them in their proper situations; and whilst it is the universal mechanical cement, or medium of connexion between them, it is at the same time admirably adapted to facilitate their relative movements and mutual actions, which are required for the performance of their respective functions.

M nical
pro ties.

Elasticity.

Cellular
contractility.

(121.) Another property, besides elasticity, has also been ascribed to the cellular substance and other textures derived immediately from it. It consists in a peculiar kind of contractility, attended by a sudden corregation and curling up of its substance. As this property has been supposed to bear some relation to muscular contractility, we shall defer its consideration till we come to treat of that property.

2. *Adipose Texture.*

Fat.

(122.) This texture contains the oily secretion which is known by the name of *fat.* The adipose matter, or fat, is lodged in particular portions of the cellular texture, appropriated to this office. It consists of very minute grains or globules, distinguishable only by the aid of the microscope. Each of these globules is contained in a separate investment, or sac, constructed of an exceedingly fine and delicate membrane, formed out of the constituent plates of the cellular substance, and having no external opening. The size of these vesicles is stated to be from the eight-hundredth to the six-hundredth part of an inch in diameter. They are collected together in small rounded masses, united by vessels, and presenting an appearance under the microscope, not unlike that of a bunch of grapes. They are lodged in the cells of the cellular substance in various situations throughout the body, and contribute to fill up the hollows which occur in different places between the bones and muscles, and other organs. They are very abundant immediately under the skin; and in some parts are evidently interposed as cushions for the protection of organs exposed to injury from pressure or other mechanical violence.

Contained
in separate
cells.

It is evident that the cells in the cellular substance which are occupied by the fat, are different from those which are the seat of dropsical accumulations of fluid; and that they do not, like the latter, communicate with one another; for it is found that each portion of fat always remains stationary in the same cell in which it was originally lodged.

Its properties.

(123.) The fat varies considerably in its consistence in different parts of the body, according to the purpose it is intended to serve. At the usual temperature of the living body, however, it is retained very nearly in a state of fluidity. The quantity accumulated in the body is very different at different periods of life; and varies also according to the state of health, and the peculiar habit and constitution of the individual. It is whiter in its colour, and more firm in its consistence, during the earlier periods of life, and becomes more soft, and acquires a yellow tinge as age advances.

(124.) The fat of animals has been resolved by *Chevreul,* who undertook an elaborate analysis of this substance, into two proximate principles, to which he gives the names of *stearin* and *elaïn.* The former, derived from the Greek word στεαρ, signifying tallow, is of a much more solid consistence than the latter in ordinary temperatures, and does not melt under a heat of from 110° to 120° of Fahrenheit. It is obtained from fat by digesting it in alcohol, in the form of white crystalline needles, which are deposited as the fluid cools. It is a white brittle substance, void of taste or odour, and resembling wax in its appearance. If, after the stearin has been deposited, heat be applied to the remaining solution, so as to drive off the alcohol, there remains an oily matter, which continues fluid at 59° of Fahrenheit, and is called, by *Chevreul*, *elaïn*, from the Greek term for oil, ἐλαιον.

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[1] Page 26, et seq.

The consistence of the fat of different animals, and in different parts of the same animal, admits of considerable diversity, according to the proportions in which these two ingredients are contained; the abundance of stearin is the principal cause of the hardness of tallow or suet, whilst an increased proportion of elain characterises the composition of marrow, which is one of the most fluid kinds of fat.

Marrow.

(125.) The marrow which occupies the central cavities of the cylindrical bones, and which also exists in small quantities in the canals that pervade the substance of the denser portions of the bones, is perfectly analogous in its composition and structure to the fat in other parts of the body. The oily particles are contained in membranous vesicle, which are themselves connected together, and retained in their places by a fine net-work of plates and fibres, corresponding to the general cellular structure of other parts, but of a peculiarly delicate contexture.

3. *Membranous Structures.*

Membrane.

(127.) When the texture of cellular substance becomes consolidated by the intimate adhesion of the plates and fibres of which it is originally composed, which, of course, produces the complete obliteration of its cells, it constitutes the different varieties of *membranous structures*. These structures are of different degrees of thickness, and compose masses of different degrees of density. When expanded into a continuous sheet or plate, it forms what is more properly termed a *membrane*. These membranes, when sufficiently thin, are semi-transparent, and have a smooth and uniform surface. Haller found that all membranes are resolvable, by long maceration in water, into a flocculent spongy substance, in which the original cells of the cellular texture from which they were formed, could be rendered apparent by inflating them with air.

Their impermeability to fluids.

(128.) Membranes retain almost all the mechanical properties belonging to the cellular substance from which they are derived; for they are equally flexible and elastic, although possessing superior strength and firmness. But in one respect they exhibit a marked difference, while the simple cellular texture, as we have seen, allows of the general communication of fluids introduced into its cells, from one part to another; membranes are for the most part impermeable to fluids, and are in consequence employed with the express design of preventing their diffusion.

(129.) The property possessed by membranes of contracting in their dimensions by the evaporation of the water they contain, and which is united with the animal material by a very weak affinity, constitutes what may be termed the *hygrometric property*.

All the membranes are capable of being dried by the continued application of a moderate heat, and may be kept in this dry state for a great length of time without undergoing any change. But if a dry membrane be immersed in water, it absorbs a considerable quantity, recovers its softness and flexibility, and expands in all its dimensions. These effects are greater when the action of warmth is combined with that of moisture. A membrane will absorb moisture even from the atmosphere, and again part with it, according to its different states of humidity. Philosophers have availed themselves of this property in the construction of an hygrometer, or instrument for indicating these varying states of the atmosphere with respect to dryness or humidity. Any long slip of dried membrane, suspended in the air, and stretched by a moderate weight, may be made to act on a moveable index by any mechanical contrivance rendering the variations in its length visible on a large scale, and will serve the purpose of an hygrometer. The membrane will be found to lengthen by exposure to a humid atmosphere, from which it imbibes moisture, and again to contract by the evaporation of this moisture in a drier air.

A piece of catgut, which is prepared from the membrane of a sheep, will answer the same purpose. We find, accordingly, that the state of the weather has a considerable effect upon the tone of a musical instrument made of catgut. A violin, or harp, may be in perfect tune in one situation, and yet become quite out of tune when placed in an atmosphere of greater humidity, as in that of a room filled with company.

The principle of which these facts are illustrations, is to a certain extent applicable to the animal body. The doctrine of the animal fibres being braced or relaxed, which was formerly a more fashionable language than it is at present, may perhaps have been carried too far, but it has certainly a foundation in truth. Warmth and moisture have a powerful influence on the body, and their effect is partly mechanical; and this operation, which is primarily exerted on the skin, renders them efficacious in the relief of inflammatory action, by diminishing the tension of the inflamed parts. This effect is not merely temporary, but may become the permanent habit of the system. Thus, we find that the inhabitants of elevated countries where the air is peculiarly dry, are more hardy, and possess more of the *vis tonica* in their frames, than those who dwell in a humid climate, or in low and swampy plains. The Swiss and other inhabitants of mountainous tracts, may in this respect be contrasted with the Dutch and Flemish, who have in general a constitutional laxity of fibre; and similar differences have been observed in the lower animals among varieties of the same race.

(130.) All these properties of membrane, taken together, adapt them for being employed in various useful ways in the animal economy. Membranes in general are employed to establish relations not only between adjacent, but also between distant parts; they strengthen their connexions, and, whilst in some they allow of relative motions in certain directions, and to a certain extent, in others they restrain them and limit their degrees. Almost every organ is furnished with a firm covering of membrane, which gives it protection and support. For all these purposes, a looser and more yielding cellular tissue would not have possessed adequate strength.

Vessel &c.

(131.) As the cellular substance is the basis of membrane, so membrane, in different modifications, constitutes the essential portion of many other parts of the body; such as all those recipient organs, having the form of sacs or pouches, like the stomach, and especially those which are provided for the retention of fluids, as the gall-bladder, and urinary bladder. Membranes are also formed into tubes of various kinds, destined to transmit their fluid contents to various parts. These tubes, known under the name of *vessels*, *canals*, or *ducts*, are also frequently furnished with a valvular apparatus, likewise composed of membrane, allowing of the passage of the fluid only in one direction.

(132.) The structure and properties of every description of membranes have been minutely investigated by Bichat, who, in his *Anatomie Générale*, has given us an elaborate classification of the animal textures. He establishes two general divisions of membranes, namely, the simple and the compound. Of the former he makes three classes; first, the mucous membranes, the surface of which is defended by a mucous secretion; secondly, the serous membranes, characterised by the serous nature of the fluid with which their surface is constantly moistened; and thirdly, the fibrous membranes, which are distinguished by their peculiar structure, as being composed of dense and inelastic fibres. The compound membranes are formed by the intermixture of two or more of the simpler membranes, and exhibit a combination of the characters of each.

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(133.) *Serous membranes* are universally met with whereever there are internal cavities in the body, which are closed on every side, that is, have no communication, by any channel, with the external air; such cavities being always lined by serous membranes. This is exemplified in the cavities of the chest, which are three in number; namely, one on each side, containing the right and left lung, and the intermediate cavity, occupied by the heart. The membranes lining the former are called the *pleuræ;* and the membrane lining the latter, the *pericardium.* The great cavity of the abdomen, in which are situated the organs of digestion and chylification, is lined by the *peritoneum,* which is also a serous membrane. The same, also, applies to the cavities in the interior of the brain, which are called *ventricles,* and also the external surface of the organ, which are lined by the *dura mater,* the *arachnoid coat,* and *pia mater.* The serous membranes, after lining their respective cavities, are extended still farther, by being reflected back upon the organs inclosed in their cavities, so as to furnish them with an external covering. If it were possible, therefore, to dissect these membranes from off the parts which they invest, they would have the form of a sac without an opening, the organ invested by one of their folds, being altogether external to the cavity of that sac; just as happens when a double night-cap is worn, of which the part immediately covering the head is analogous to that portion of the serous membrane which adheres to, and invests the organ; whilst the external portion of the cap represents the lining of the cavity in which that organ is said to be contained.

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(134.) Hence it will readily be understood, that the serous membranes never open, or allow of any perforation, for the passage of blood vessels, nerves, or ducts, to or from the enclosed organs; but that they are always reflected over those parts, forming a sheath round them, and accompanying them in their course. It also follows, as a necessary consequence, that their free surfaces completely isolate the parts between which they intervene. The great viscera, suspended in the bags formed by their serous coverings, can have no communication with the adjacent parts, except at the points where their vessels enter; in all other situations there is no continuity of parts, although there may be contiguity.

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sur s.

(135.) In every serous membrane we may distinguish two surfaces having very different characters: the external surface, or that by which they adhere to the surrounding organs, and the internal surface, which is in immediate contact with another portion of the same membrane, but without adhering to it. This interior surface is remarkable for its perfect smoothness and polish; and it is continually preserved in a state of moisture by a serous fluid, which exudes from it. This fluid has been termed the *liquid of surfaces,* and consists almost entirely of water, with a very minute proportion of albuminous matter. Its presence is evidently of the greatest use in facilitating the motions of the parts contained within the cavities, with relation to their sides, by diminishing friction, preserving the smoothness of the surfaces applied to each other, and preventing their mutual adhesion. When the internal surface of these membranes is exposed to the air in living animals, or immediately after death, this fluid exhales in the form of vapour, to which formerly great attention was paid, and which was dignified with the name of *halitus.* In consequence of disease, this fluid of surfaces sometimes accumulates in one of these cavities, and thereby produces a dropsy of that respective cavity: a fact which proves the power of serous membranes to retain these fluids, and not, as in the case of the cellular substance, to allow of their diffusion into the adjoining organs.

(136.) The serous membranes constitute the simplest form of condensed cellular substance; they are not divisible into any regular layers; although cellular portions may be removed from the outer surface by which they are attached to the surrounding parts. In the natural state they are exceedingly thin, and transparent; but become thicker and opaque by disease. Although perfectly flexible, they possess considerable strength; they are exceedingly extensible; but they are not in the same proportion elastic: for after they have been stretched, they give but feeble indications of a power of retraction.

4. *The Osseous Fabric.*

Properties of the bones.

(137.) For the purpose of thoroughly understanding the whole mechanism and operations of any complicated engine, or system of machinery, the best and most natural course is to commence with the study of the solid frame-work, which gives stability to the whole fabric, and affords fixed bearings from which the powers, regulating the movements of its different parts, exert their respective powers. This purpose of procuring mechanical rigidity and support, is the appropriate function of the osseous system, or *skeleton;* which is composed of a connected series of solid structures, called *bones,* deriving their mechanical properties from their peculiar chemical composition, and almost crystalline hardness, and which constitute one of the most important of the constituent textures of the body. Our first object of attention, therefore, in considering the mechanical functions, is the study of this system of structures.

(138.) The bones, then, are to be viewed as the densest and most solid parts of the animal frame; constituting the basis of support to the softer textures, affording protection to all the vital organs, and furnishing those powerful levers which are essential to the advantageous action of the muscles concerned in locomotion, and in the various movements of the limbs. With reference to their form, they have usually been divided into three classes: the *long cylindrical bones;* the *broad and flat bones;* and the *short or square bones,* which include those of a more irregular form, and not referable to either of the other two heads. To the first class belong the principal bones of the upper and lower limbs, which are adapted more especially to the purposes of motion. Under the second may be ranked the bones of the skull, which serve for the protection of the brain; and the third include the vertebræ, the bones of the face, and the small bones which concur in the formation of the wrist and the ankle. There are, besides, other bones, such as the ribs and the bones of the pelvis, of a more anomalous description, which are rather distinguished by their irregularity than by any definite character.

Structure of bones.

(139.) On examining the mechanical structure of bones, we find that their external surface is generally their hardest part, and that it consists of a solid plate, or layer of bony matter, of different thickness in different bones, and in different parts of the same bone. In the cylindrical bones this firm and compact substance extends only to a certain depth, and within this the structure is spongy and cellular. To the latter part the name of *cancelli* has been given. In the middle of the long bones the central parts are occupied by the marrow; but as we continue our examination, by taking different sections across the bone, in proportion as we approach the extremities, we find the dense external substance diminishing in thickness, while the proportion of the spongy part increases, and encroaches upon the space in the centre occupied by the marrow, which at length disappears, so that at the very extremity of the bone, nearly the whole area of the section is filled by the cancelli, while the outer covering of solid bone is merely a thin superficial plate. In the flat bones, having, of course, an upper and under surface, the plates of bone forming each of these surfaces, are termed the two *tables*, and the cellular portion which is found between them is called the *diplöe*. In many of the more irregularly shaped bones, neither cancelli nor diplöe are found, the whole substance being compact. Dr. Bostock observes, that the transition from the compact to the spongy part of a bone is not marked by any decided limit; but they pass into each other by insensible degrees, so as to shew that there is no essential difference between them.[1]

(140.) Bones present the appearance of fibres on their surface. This is seen particularly in all bones that have been long exposed to the weather, or that have been long boiled. In the cylindrical bones most of these fibres are longitudinal; but in the flat bones they generally run in a radiated direction. In the short bones their course is much more irregular and difficult to trace. In the compact part of the section of a bone, the appearance of plates is not very distinguishable; but certain cavities are discovered which, for the most part, run in a longitudinal direction, and nearly parallel to one another. They are of various lengths; and their diameters are exceedingly small. They have transverse or oblique canals, which establish communications between them; and some of which also open into the larger cancelli in the middle of the bone. These cavities have been called the canals of Havers,[2] who first discovered them. Their existence, however, was for a long time considered as dubious; but it has been lately verified by Mr. Howship,[3] who, with the help of the solar microscope, obtained distinct views of them, and was enabled to trace their course. He ascertained the diameter of these canals to be about the 400th of an inch; and farther discovered that they are lined with an extremely fine vascular membrane, and that they are filled with marrow.

(141.) The intimate structure of bone was first minutely investigated by Malpighi, who discovered that its basis consists of an animal membrane having an areolated, or cellular form. Duhamel[4] next ascertained that this membranous matter was frequently disposed in plates or laminæ; and he described these plates as forming concentric rings, analogous to those which compose the trunk of a tree; but there is no other foundation than mere fancy for this analogy. We owe to Herissant[5] the important fact, that the chief properties of bone are derived from the presence of an earthy ingredient, which is deposited in the animal basis, or parenchyma of the bone.

Analysis of bone.

(142.) The analysis of a bone into its two constituent parts is easily effected by the agency either of acids or of heat. By macerating a full grown bone for a sufficient time in diluted muriatic acid, the earthy portion of the bone, amounting to nearly one-third of its weight, is dissolved by the acid; the animal portion only remaining. This animal basis retains the bulk and shape of the original bone, but is soft, flexible, and elastic; possessing, in a word, all the properties of membraneous parts, and corresponding in its chemical character to condensed albumen.[6] A portion of this solid animal substance affords gelatine by long boiling in water, especially under the pressure, admitting of a high temperature, to which it may be subjected in Papin's digester. On the other hand, by subjecting a bone to the action of fire, the animal part alone will be consumed, and the earth left untouched, preserving, as before, the form of the bone, but having lost the material which united the particles, presenting a fragile mass which easily crumbles into powder. This earthy basis, when chemically examined, is found to consist principally of phosphate of lime, which composes eighty-two hundredths of its weight; and to contain also, according to Berzelius, minute portions of fluate and carbonate of lime, together with the phosphates of magnesia and of soda.

Dr. G. O. Rees, who has lately made exact analysis of different bones taken from the same individual, in a state of perfect dryness, and quite free from fat, periosteum, or cartilage, deduces from his researches the following conclusions:[7]

1. The long bones of the extremities contain more earthy matter than those of the trunk.

2. The bones of the upper extremity contain somewhat more earthy matter than the corresponding bones of the lower extremity; thus the humerus more than the femur, and the radius and ulna more than the tibia and fibula; this difference is, however small, being about one half per cent.

3. The humerus contains more earthy matter than the radius and ulna, and the femur more than the tibia and fibula.

4. The tibia and fibula contain, as nearly as possible, the same proportions of animal and earthy matter, and the radius and ulna may also be considered alike in constitution.

5. The vertebræ, ribs, and clavicle, are nearly identical as regards the proportion of earthy matter; the ileum contains somewhat more of the earth, the scapula and sternum somewhat less: the sternum contains more earthy matter than the scapula.

6. The bones of the head contain considerably more earthy matter than the bones of the trunk, as observed by Dr. J. Davy; but the humerus and other long bones are very nearly as rich in earths.

7. The metatarsal bones may probably be ranked with those of the trunk in proportional constitution.

8. The cancellated structure (at least in the rib) contains less earthy matter than the more solid parts of the bone; this difference, however, is not considerable.

9. The bones of the trunk of the fœtal skeleton are as rich in the proportion of earthy matter as those of the adult; at least the difference is too small to be material.

10. The bones of the fœtal extremities, on the other hand, are deficient in earthy matter, which is a fact simply explicable from the circumstance that such an excess of earths as appears necessary to very great strength of bone is not needed at birth, and therefore only appears in after life.

The existence of a general law, regulating the proportion of earthy deposit in the different bones, (which is shown by the curious agreement of relative proportions observed between the fœtal and adult skeletons,) adds one more to the many proofs of the regularity and perfection of design which nature evinces in her operations.

(143.) It appears evident, then, from these and other facts, that the basis of the osseous structure is essentially the same as that of membraneous parts, being composed of fibrous laminæ or plates, which are connected together so as to form, by their intersection, a series of cells analogous to those of the cellular texture. In the interstices of these plates, or in the cells themselves, the particles of phosphate of lime are deposited; the particles being held in union by the interposed membrane, which performs the office of a cement. Hence there is no necessity for admitting the hypothetical explanation of Gagliardi,[8] who maintained that the bony plates are held together by small processes, like nails, which, rising from the inner plates, pierce through the adjoining ones, and are fixed into the more external plates. Of these processes, or *claviculi*, as he called them, he described four different kinds, the perpendicular, the oblique, the headed, and the crooked. But no subsequent anatomist has been able to verify these observations; and the account given by Gagliardi remains on record as a curious instance of the extent to which an observer of mere appearances is liable to deceive himself by the influence of too vivid an imagination. Monro states, that in bones fitly prepared, he could only see numerous irregular processes rising out from the plates. Duhamel, trusting to a fancied analogy between the process of ossification, and the growth of trees, imagined that a bone is composed of a series of regular concentric laminæ. But this hypothesis has been refuted by Scarpa,[1] who investigated, with great care, both the mechanical structure of bone and the mode of its formation; and concludes that the ultimate texture of bone is not lamellated but reticular. Raspail has indulged in speculations of a still more questionable nature respecting the ultimate osseous texture, which he endeavours to assimilate with that vesicular form, which he views as the essential character both of animal and of vegetable organization. Dr. Benson observes[2] that all writers, before the time of Scarpa, considered the structure of bone as laminated, or fibrous and laminated; whilst, according to all later authorities, it should be regarded as cellular. In the works of the former, however, we may notice intimations of a reticular texture; and in those of the latter, on the other hand, we meet with the expressions of a *tendency* or *disposition* to a laminated arrangement. "If, with these opinions before us," he continues, "we come to examine for ourselves, we shall have no hesitation in agreeing with Scarpa that it is really cellular. At the same time, it must be confessed, that the sides of the cells are, in the compact tissue, so pressed together, that the appearance of laminæ is often very striking; and, again, that the sides of the cells have, in most places, the appearance of fibres; when the earthy portion is removed by an acid, we can tear out with a pin the membranous fibres, and almost demonstrate the fibres. But a closer examination will shew that we have torn the cells, and destroyed the true texture. The laminated disposition supposed to be shewn by exfoliation, the weather, burning, &c., may all be proved to be deception; and there can seldom, indeed, be exhibited a plate, however small, of equal thickness throughout, which has been removed by any of these agents. There is, however, an approach to the laminated arrangement, and every cell is formed of particles which approach to the form of fibres. The longitudinal canals of Havers, Leuwenhoeck, and Howship, probably result from the flattened cells, and may be deceptive appearances in the old bone, or the channels for blood vessels, &c."

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[1] *Elementary System of Physiology*, third edition, p. 61.

[2] *Osteologia nova*, § 35, 37.

[3] *Medico-Chirurgical Transactions*, vii. 393.

[4] *Mémoires de l'Académie des Sciences*, pour 1739, 1741, 1742, and 1743.

[5] Ibid. 1758.

[6] This was first satisfactorily shewn by Mr. Hatchett. *Phil. Trans.* for 1800.

[7] *Medico-Chirurgical Transactions*, xxi. 409.

[8] *Anatomia Ossium.*

osteum

(144.) Bones are invested on every part of their surface, excepting in those parts where they are plated with cartilage, with a firm plate of membrane, termed the *periosteum*, which conveys blood vessels to the bone, and establishes mechanical connexions between it and surrounding parts. This membrane belongs to the class of fibrous textures, being composed of numerous inelastic fibres of great density and strength, passing in various directions, and composing a kind of ligamentous tissue, interlacing with the fibres of the ligaments which encircle the joints.

row.

The inner surface of the periosteum is connected with the bone by the vessels passing from the one to the other, and also by numerous prolongations which dip down into the osseous substance. The blood-vessels of this membrane are numerous, and easily rendered apparent by means of injections, especially in young subjects. Besides the more obvious uses of the periosteum, in affording protection to the surface of bones from injurious impressions they might receive from the action of surrounding parts, and interposing a membranous layer for the defence of the latter, Bichat ascribes to it the more important office of affording fixed centres of support to the general system of fibres, in its mechanical relations to the rest of the frame. The periosteum which covers the bones of the skull has received the name of the *pericranium*.

(145.) The internal cavities of the bones are, as is well known, occupied by an oily secretion, termed the *marrow*, contained in a delicate structure, composed of minute vesicles which are filled with the fluid oil, and which are connected by fine threads and plates of fine cellular tissue. Monro describes the vesicles as perfectly distinct, having no communication with one another, and as presenting, under the microscope, the appearance of a cluster of pearls.

Many have been the conjectural uses assigned to the marrow by the older physiologists; it was at one time very generally imagined that it served, by its mechanical properties, to temper the brittle quality of the earthy materials which form the chief constituent portion of the bone; a purpose, however, which it is impossible it could fulfil, as, instead of being mixed up and blended with the phosphate of lime, or diffused generally through the substratum of the bone, it is lodged in separate cavities, and thereby prevented from any union with bony matter, or intermixture with its substance. The marrow is, in general possessed of little sensibility, except in a few points, where it is traversed by the nervous filaments supplying the bone itself. It is regarded by physiologists of the present day rather as constituting a part of the general store of nutritious matter, which is kept in reserve for particular occasions of exigency, than as having any mechanical relation with the dense texture within which it is lodged. The circumstance of its being wholly absent in the bones of birds is a clear proof that there is no mutual dependence between the functions of the latter and the presence of the marrow.

Internal periosteum.

(146.) All the internal cavities of bones occupied by the marrow are lined with a vascular membrane, which follows all the windings of the canals and of the cancelli, and has been called the *internal periosteum*. It may easily be rendered visible by sawing a long bone longitudinally, and plunging it in boiling water, by which treatment the membrane is made to detach itself from the bone, and contract upon the marrow which is within it, and to which it is closely attached. It has then the appearance of a fine cobweb.

5. *Cartilage.*

Properties of cartilage.

(147.) The structure which ranks next to bone in respect to its density is *cartilage*, a term which expresses a firm and dense substance, apparently homogeneous in its texture, semipellucid, and of a milk-white or pearly colour. Substances of this description are found to enter into the composition of several parts of the body. The surface of a cartilage is perfectly uniform, and presents no visible eminences or pores; nor can any cavities or inequalities of any kind be perceived in its internal texture. When it is cut into with a sharp knife, the section exhibits an uniform appearance, like that of a piece of glue. Yet, after exposure for a certain time, the surface thus cut begins to contract, and a serous fluid is perceived slowly to exude from it, proceeding from certain invisible pores, which are in all probability minute capillary vessels, of which the diameters are too small to admit the coloured globules of the blood. That a delicate system of circulating passages exist in cartilages, is shewn by various diseased conditions, in which sometimes granulations have been seen to arise from their surfaces, and at other times extensive absorption of their substance has taken place; and although insensible, on ordinary occasions, to wounds inflicted by cutting instruments, yet in others, when sudden pressure is made on them under peculiar circumstances, extreme pain arises, giving warning of serious injury impending.

Cartilaginous structures appear to be composed of albumen alone, with scarcely any intermixture of gelatin. Dr.

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[1] *De Perit. Structura Ossium.*

[2] *Cyclopædia of Anatomy and Physiology*, vol. i. p. 433.

John Davy found that they contain a small proportion of phosphate of lime, amounting to about the two hundredth part of their weight. Mr. Hatchett, however, does not regard this substance as an essential ingredient in their composition.

The mechanical property which particularly distinguishes cartilage is elasticity, a quality which it possesses in a greater degree than any other animal structure, and which adapts it to many useful purposes in the economy. Hence it forms the basis of many parts where, contrary to the purposes answered by the bones, pliancy and resilience as well as firmness are required; and hence cartilage is employed when a certain shape is to be preserved, together with a capability of yielding to an external force. The flexibility of cartilage, however, does not extend beyond certain limits; if these be exceeded, fracture takes place. Great density bestowed upon an animal structure, indeed, appears to be in all cases attended with a proportionate degree of brittleness. These mechanical properties of cartilages, as well as their intimate structure, although nearly homogeneous in all, are subject to modification in different kinds of cartilage. Cartilages are covered with a fine membrane, termed the *perichondrium*, analogous in its structure and office to the periosteum, which we have already had occasion to point out among the fibrous membranes, as investing the bones.

Cartilages, temporary and permanent.

(148.) Cartilages are distinguished into those which are *temporary* and those which are *permanent structures*. The former are only met with in the earlier periods of life, during the growth of the body, and are gradually removed to make way for the deposition of bone. When about to undergo this change, small canals have been detected in the substance of these temporary cartilages. The permanent cartilages are those which retain the cartilaginous structure throughout every period of life. They have been distinguished into three or four different kinds, such as the membraniform, the interosseal, the articular, and the interarticular cartilages.

Membraniform.

(149.) The *membraniform cartilages* are included by Bichat in the class of fibro-cartilaginous structures hereafter to be described. They furnish a basis of support to the softer parts, and in some measure supply the place of bone, giving a determinate shape and firmness to parts where bone would have been inconvenient. They possess greater tenacity and less brittleness than the other kinds of cartilage. By their elasticity they admit of considerable variation of figure, yielding to external pressure, and recovering their proper shape as soon as the pressure is removed. Of this kind are the cartilages of the nose and ear, and also those of the larynx and trachea. These cartilages are extremely thin, and are invested with a very thick and firm perichondrium, to which they are connected by means of a number of fibres traversing their substance, and rendering their surfaces rough and porous. Long maceration enables us to detect these fibres, and to resolve the whole into a cellular and albuminous substance.

Interosseal.

(150.) The *interosseal cartilages* pass from one bone to another, adhering firmly by their extremities to each. They answer the same purpose as would be attained by an increase of extent in one or both of the bones, with the further advantage of allowing of obscure degrees of motion, and deadening the effects of jars incident to percussion. The cartilages of the ribs are of this class. They are covered with perichondrium. When they have been steeped in water for a great many months, they are divisible into laminæ, of an oval shape, which are united by fibres passing obliquely between them.

Articular.

(151.) The *articular*, or *diarthrodial cartilages*, are those plates of cartilaginous substance which adhere firmly, and almost inseparably, to the surfaces of those bones which are opposed to each other in the joints, or over which tendons and ligaments slide. In some joints the whole of the surface of the bone within the capsular ligament is covered with cartilage; in others, only the parts of bones which move upon each other; the remaining part being covered with ligament. This latter disposition is met with in the joint of the hip. This kind of cartilage, like the others, appears perfectly smooth on its surface, and also when a section is made through its substance; but by a sufficiently long maceration, to allow of a commencement of putrefaction, its fibrous structure may be detected. The elastic resilience of these cartilages has a powerful tendency to lessen the shocks incident to sudden and violent actions.

Interarti cular.

(152.) Cartilages of a similar kind are found in the cavities of certain joints, and have hence been called *interarticular cartilages.* They have no immediate connexion with the bones forming the joint, but are attached only to the inside of the capsular ligament. They are thus rendered somewhat moveable, and being interposed between the bones, allow them a greater latitude of motion, while they at the same time contribute to adapt their surfaces more perfectly to each other. By long maceration in water, a laminated structure is more distinctly perceived in this kind of cartilage than in any of the others.

6. *Fibro-Cartilaginous Structures.*

(153.) Many structures exist in the human body which appear to be of an intermediate nature between ligament and cartilage, in which a fibrous texture is united to a cartilaginous basis, and which combines the characteristic properties of both these textures. They are distinguished from the purely ligamentous parts by their high degree of elasticity, and from cartilage by their fibrous texture. Accordingly we find them employed when this combination of properties is requisite for the functions of the parts. They form additions to interarticular ligaments, and eke out the borders of cavities adapted to the reception of the rounded heads of bones.

Interver bral sub stances.

(154.) The principal instances of large masses of fibro-cartilaginous structures occur in those which unite the bodies of the vertebræ and of the bones of the pelvis. These *intervertebral substances*, as they are termed, impart great elasticity to the spine; and diminish the effects of concussion. When the body has been long in the erect position, the weight of the head and upper parts of the trunk occasions the compression of these intervertebral substances, and the height of the person is diminished. By continuance for an equal time in a horizontal posture, this superincumbent pressure being removed, they recover their original dimensions. Hence a person is taller when he rises in a morning than after sustaining the fatigues of the day; and the difference of stature often amounts to a whole inch.

7. *Ligamentous Structures.*

Ligame tous sys tem.

(155.) Structures possessing inferior degrees of solidity, but still exhibiting structures of considerable density, are met with in the interior of the body, and serve various mechanical purposes of cohesion and support. Many of these may be regarded as mere modifications of membrane; but yet the peculiarities of structure and of properties exhibited by ligamentous textures point them out as requiring to be classed separately. Bichat, who has viewed them as composing a system of structures, has given to it the title of *the fibrous system;* a name which is liable to the objection of not being sufficiently distinctive; since, as we shall afterwards find, many other parts, and especially the muscles, are no less fibrous than the tendons and the ligaments. As a general designation of this class of fibres, we have therefore preferred the term of *ligamentous system*, which sufficiently expresses the general mechanical purpose which they are designed to serve in the animal economy.

(156.) This system includes a great number of structures, which, although very similar in their nature and office, have received different names, such as *ligaments, tendons, fasciæ, aponeuroses, capsules,* &c. Fibres of a similar kind to those which constitute these parts, also enter into the composition of other organs, imparting to them different degrees of mechanical strength.

(157.) Various as are the forms and dispositions assumed by ligamentous fibres, they present us with two principal varieties, according as they are expanded into thin and broad plates, or ligamentous membranes, or collected into thick and elongated cords. The first division includes fibrous membranes, fibrous capsules, tendinous sheaths, and aponeuroses.

rous mbranes.

(158). *The fibrous membranes* resemble ordinary membranes, but have, superadded to the structure of the latter, numerous denser fibres, which give them greater strength, and fit them for affording mechanical support to various organs. Thus the periosteum of the bones is a membrane of this description. The internal periosteum of the skull or *dura mater* has a similar structure. The external coat of the globe of the eye, or *sclerotica;* the investing membranes of many of the glands, as the kidneys, belong to the class of fibrous membranes; to which also we may perhaps refer some of the coats of the larger blood-vessels, and of the excretory ducts of glands. Besides enveloping organs, these fibrous membranes often extend into their interior, forming partitions, or even cells, which contribute to their firmness and support.

I ous c ules.

(159.) *The fibrous capsules* present the form of sacs, which surround certain joints, especially those of the shoulder and hip, and preserve the connexion between the bones which form these joints. These capsules, again, are lined internally by serous or synovial membranes, supplying the fluid which lubricates the surfaces of the parts playing upon each other.

S ths of te ons.

(160.) *The tendinous sheaths* are formed by fibrous membranes of a cylindrical shape, which surround the tendons in those parts where they pass over bones, and are particularly subjected to friction, or liable to occasional displacement during the action of the muscles which move the joint. Some of these include only one tendon in their respective cavities, as those of the fingers and toes: others receive several tendons, as those belonging to the muscles of the wrist and ankle joints.

A eu- ro

(161.) *Aponeuroses* consist of extended sheets of fibrous texture, principally belonging to the organs of locomotion; and disposed in some instances so as to form coverings of parts; while in others they constitute points of attachment to muscles. Thus they may be distinguished into aponeuroses for enveloping, and aponeuroses for insertion. The former, which are generally termed fasciæ, either surround the muscles of the limb, forming a general sheath for it, as in the fore-arm and thigh; or else they invest and confine some particular muscles. The aponeuroses for insertion either form broad or narrow surfaces, or consist of separate fibres, giving attachment to particular portions of muscles, or form arches, which both admit of their connexion with muscular fibres, and at the same time allow of the passage of vessels.

(162.) The second division composes the proper ligaments and tendons, all of which have more or less the form of cords.

Lig ents.

The *ligaments* connect together the articular surfaces of bones, and oppose a very considerable resistance to any force tending to their displacement. The fibres which enter into their composition, generally preserve a direction nearly parallel; but frequently they are extended in various ways, forming an intertexture calculated to resist extension in different directions; and from their mere flattened form, bringing these ligaments nearer to the description of fibrous membranes.

Tendons.

(163.) The *tendons* are generally more simple in their structure, consisting of elongated cords; but in some instances they are more complicated, being divided into several smaller cords.

Bichat's arrangement.

(164.) Bichat[1] has exhibited, in the following table, a general view of the preceding classification of what he calls the *fibrous system.*

- Fibrous organs,
  - In the membranous form.
    - Fibrous membranes.
    - Fibrous capsules.
    - Fibrous sheaths,
      - Partial.
      - General.
    - Aponeuroses.
      - For envelopment.
        - Partial.
        - General.
      - For insertion
        - In a broad surface.
        - In an arch.
        - In separate fibres.
  - In the form of cords.
    - Ligaments.
      - With regular fasciculi.
      - With irregular fasciculi.
    - Tendons.
      - Simple.
      - Complicated.

Albugineous fibre.

(165.) The structure of all these parts, as their name imports, is essentially fibrous; the individual fibres which compose them being exceedingly slender filaments of a very dense, firm, and inelastic substance; sometimes parallel to each other, as in the tendons and ligaments, and sometimes variously interwoven, as in the fibrous membranes. In some portions of the denser structures hereafter to be noticed, the fibres are so closely united as to present an almost homogeneous appearance; but in all the parts hitherto considered, the bundles of fibres admit of being separated by maceration; and are resolvable into lengthened filaments of extreme tenuity. It has not been perfectly ascertained what is the diameter of the fibres when this subdivision has been carried to its utmost limit; but they appear in this ultimate state of division to be as fine as the filaments spun by the silk worm. These ultimate fibres are distinguished by their flexibility, their extreme tenacity, and their brilliant whiteness. They are probably in no case tubular, but solid throughout, although Mascagni, extending to them his general system of organic textures, regards them as formed of lymphatic vessels. Chaussier,[2] with great appearance of truth, considers them as a peculiar and primary organic tissue, to which he has given the name of the *albugineous fibre,* in order to distinguish it from the mere simple cellular or membranous fibre, which constitutes the basis of the general substance of the body.

(166.) The fibres which enter into the composition of these ligamentous textures, are united by a cellular tissue of extreme fineness and tenuity, which is rendered evident after maceration when the ligamentous fibres are drawn asunder. Their arrangement at the surface of these structures is such as to produce that glistening and satin-like lustre which results from a surface of high polish and density; an appearance which is very characteristic of the fibrous structures. This smoothness and resplendent white colour is possessed in the greatest degree by tendons, which have in general a greater extent of motion than the ligaments, and therefore require a higher degree of polish.

Sect. III.—*Mechanical Connexions.*

1. *Articulation.*

Variety in the modes of connexion.

(167.) Having noticed the properties of those elementary textures that furnish those cohesive and resisting forces which are necessary for the mechanical purposes of the animal fabric, we have next to review those combinations of structure which have been adopted for establishing the connexions between the various parts of the frame, and which adapt them to those objects. These modes of connexion admit of great variety, according to the different mechanical relations which must take place between them; and more particularly with reference to the degrees of mobility which are to result from their union. In many cases the parts placed in juxtaposition require to be fixed in their places by the firmest bonds which can secure their relative immobility: in others, the freest motion must be allowed; while in various other instances, we find almost every intermediate degree of flexion allowed, and every kind of connecting mechanism employed. But from the deep implanting of the teeth in the jaws, like nails firmly fixed in wood, and the mutual locking in of the bones of the skull by indented sutures, like the dove-tailed junctions of carpentry, to the freely rotating joints of the limbs, as in those of the shoulder or the hip, we may trace various modes of articulation which are calculated to limit the extent and to regulate the kind of movements, in subordination to particular ends. There is certainly no part of the human fabric, wonderfully and fearfully as the whole of it has been made, which exhibits more palpable evidences of express mechanical contrivance and adaptation to specific purposes, than the construction of the joints, and of the whole of their auxiliary apparatus. It is well observed by Paley,[1] that every joint is a mechanical curiosity, and a proof of contriving wisdom. They are, indeed, as Cicero has truly expressed it, "mirabiles commissuras, et ad stabilitatem aptas, et ad artus finiendos accommodatas, et ad motum, et ad omnem corporis actionem."[2]

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[1] See his *Anatomie Générale,* tom. iii. p. 142.

[2] *Dictionnaire des Sciences Médicales.* Organization.

Joints.

(168.) There are two circumstances which determine the kind of relative motion of which a joint, by which term is more particularly meant the connexions of adjacent bones, is capable. The first of these comprises the form of the contiguous surfaces of the bones themselves which are brought to play on each other, and their mode of apposition; the second relates to the structure and mechanical conditions of the interjacent flexible parts, such as the ligaments, the cartilages, and the membranes, which impart different degrees of elasticity or springiness, and variously modify the motions which result. With respect to the first, the principal diversities arise from the various extent of range allowed with regard to the planes of motion; and these varieties are naturally distributed under two heads; the one being a semi-rotatory motion within a considerable extent of a spherical surface, as exemplified in what are called the ball and socket joints; the other, in which the angular motion is restricted to a single plane, as is the case with what are termed the hinge-joints. It is not necessary here to advert to the further distinctions to which a minute examination of all the different modifications of these kinds of mechanism, which are exhibited in the solid structures of the body, would lead us; which the older physiologists pursued with great diligence, and which they were fond of dignifying with a formidable array of technical terms; a sufficient account of these now obsolete denominations having been already given under the head of ANATOMY in this work. It will be sufficient for our present purpose to observe, in general, that the long bones of the limbs have their extremities expanded so as to form broad surfaces where they are in apposition with the contiguous bones, between which a joint is formed. In the ball and socket joint, it is the moveable bone which has the rounded head, and the fixed bone, or that nearest to the trunk of the body, which contains the corresponding cavity or socket. Such at least is the case in man; but some animals present us with examples of a contrary arrangement; that is, of the concave surface of the moveable, turning on a convex projection of the fixed bone. Bones of a flat or irregular shape are, in general, much more limited in their motions, when they form joints, than those of a lengthened cylindrical form.

(169.) In proportion to the extent of motion allowed in the joint, we find provisions adopted for diminishing friction, and guarding against injury. In all the articulations the ends of the bones which enter into their formation, are invested with a smooth and polished plate of cartilage; a substance which, by its modified hardness, and great elasticity, is especially adapted to both these purposes. Its limited degree of organization, also, gives it many advantages in withstanding the influence of pressure, especially if suddenly made, and frequently repeated. In some joints this investing layer of cartilage is of equal thickness throughout, so that it appears as a crust, regularly moulded over the articular surface of the bone which it covers, and exactly preserving its figure; but, in other cases, it is found to be thicker at the middle than at the marginal parts; thereby increasing the convexity of the projecting portion, or diminishing the concavity of those which recede; both of which appear to be provisions for ensuring, as the case may be, the uniformity of contact of the adjacent parts composing the joint. These superficial articular cartilages, or "cartilages of incrustation," as they have been termed, appear to be composed of a multitude of slender fibres, strongly adhering together, and all of them being perpendicular to the tangential planes of the surface of the bone they invest, like the pile of velvet, and disposed, therefore, in a manner very similar to that of the fibres of the enamel of the teeth, which is superimposed in nearly the same way on the bony part of the tooth. The most complete investigation of this structure will be found in a paper of Dr. William Hunter's, published in the *Philosophical Transactions*.[3] It results from this conformation, that the fibres, on the application of pressure, yield to a certain degree, and bend in waves; just as happens to velvet when it is compressed; and they again resume their perpendicular positions on the removal of the compressing force.

Synovi capsule bursæ m cosæ, alar lig ments.

(170.) The whole of the interior surface of each joint is lined with a smooth and glistening membrane of great tenuity, forming a cavity closed on every side, and supplying a peculiar secretion, termed the *synovia*, obviously intended for the lubrication of all the contiguous surfaces. Similar *synovial membranes*, as they are called, forming, in like manner, closed sacs, are met with, surrounding the sheaths of the tendons, and interposed between other parts, the motions of which would expose them to considerable friction. In the former case, when employed in the articulations, they are termed *capsules* of the joints; in the latter, they have received the inappropriate name of *Bursæ Mucosæ*. The synovia is a transparent and viscid fluid, slippery to the feel, and capable of being drawn out into strings by the fingers. It has been imagined that the secretion is principally derived from certain fringe-like processes, chiefly visible in the knee and hip-joints, and constituting what have been called the *alar ligaments*. These membranous appendages, which project into the cavity of the joint, and appear to be formed by folds of the synovial membrane, containing some cellular substance, and small pellets of adipose matter, present an appearance very similar to that of the epiploic duplicatures of the peritoneum, and especially of the appendices epiploicæ of the colon.

(171.) The motions which a joint is capable of performing are often modified and extended by the interposition of detached plates of cartilage, connected only by ligament with the synovial capsule, and capable of shifting their position, so as to enlarge the range and modify the mode of action. Those which we have already described under the title of *interarticular cartilages*, are met with chiefly in those joints where the motion is frequent and considerable, and where the ends of the bones are subjected to great pressures; as in the junction of the lower jaw with the temporal bone, and in the knee-joint. The *semilunar* cartilages, in this latter example, increase the depth of the articular cavity, and ensure, in all the motions of the joint, a perfect adaptation of the surfaces to one another.

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[1] *Natural Theology*.

[2] *De Natura Deorum*, l. ii. c. 35.

[3] For 1743, vol. 42, p. 544.

aments.

(172.) The bones are retained in connexion, their junction strengthened, and their relative movements farther regulated, by the ligaments which invest the joint. Of these there are two kinds, the *capsular*, and the *fascicular ;* the former investing the joint on all sides in the case of the ball and socket articulation; and the latter passing from bone to bone in different directions, limiting the motion more or less to a particular plane. When, in the hinge-joint, they are placed externally on the two sides, they form what are called *lateral ligaments ;* but in the case of the knee, additional securities are provided, by short and round ligaments, crossing one another in the interior of the joint; these are the *crucial ligaments*. Besides these, we often find other ligamentous bands, passing more obliquely, and dispersed in different directions, which assist in strengthening the joint, preventing the displacement of the bones, and thus completing the mechanical apparatus of each articulation. The muscles which surround the joint also contribute very powerfully in retaining the bones in their proper places, and preventing the sudden dislocations which might otherwise occur during the strains incident to rapid and violent actions.

2. *Package of Organs.*

kage of organs.

(173.) The great mechanical objects of adhesion and support being provided for by the organic systems we have now considered, our attention may next be directed to purposes of a subordinate and special nature, and which relate to local adaptations, comprehending what Paley has aptly termed the *package* of the organs. Art and contrivance have been as manifestly displayed in fulfilling these more limited objects, as in the more extended designs of the general fabric. When we consider the vast multiplicity of parts, which it requires the study of years of patient instruction and dissection to be thoroughly acquainted with, which are closely arranged and stowed in the narrow space allotted for them in the body, we cannot but be struck with the care that has been taken in their disposal in the most convenient manner, and with the greatest economy of room. The brain consists of a prodigious number of fibres, gathered together in curious folds, or convolutions, in order that they may occupy the smallest possible bulk, and be contained within the circumscribed cavity of the skull, which is to afford them protection. Within how small a compass are lodged all the delicate parts which compose the complex organ of hearing, and which are encased in a hollow space, scooped out of the most solid parts of those bones. Equal care has been bestowed in the lodgment and package of the viscera which occupy the other cavities of the body, namely, the thorax and abdomen. Those which are of greatest importance to life, and whose delicate texture admit most easily of being injured, are always placed in situations of greatest security, and effectual care is taken to provide additional protection by means of bones, cartilages, or other denser mechanical fabrics. All the organs are tied down and secured in their places by membranes, so adjusted in regard to breadth and flexibility, as to allow of those motions which their functions require ; or, in other cases, to restrain their displacement, by tightly binding them in their situations. All the important viscera are invested with coverings proper to themselves, composing capsules, which are generally of great density and strength, and calculated to give them effectual protection against pressure or other mechanical causes of injury. The muscles, which are in strongest and most frequent action, are firmly braced and tied down by sheets of fibrous tissue, inserted into the neighbouring bones, and preventing them from starting from their places when urged into sudden and violent contractions. Lastly, all the spaces intervening between the muscles, blood-vessels, nerves, and bones, are filled up with a quantity of cellular and adipose substances, sufficient to leave no vacuity. Hence arises that rounded and flowing outline which has been given to the body, and which forms one of the constituent elements of its beauty.

(174.) The provision of a general envelope to the whole of this complex system of organs, may be regarded as another consideration which appertains to the subject now before us, namely, the package of the body ; but its importance is such as to entitle it to be treated of under a separate section.

Tone, or tonicity.

(175.) This combination of structures, individually possessing different degrees of rigidity, but cemented together by a highly elastic medium, and bound down by a general envelope of considerable strength, produces a result, which, being of considerable importance with reference to the mechanical condition of the fabric, is deserving of special notice. It is matter of observation that the sum of the cohesive forces among the particles composing the mass of animal tissues, is balanced, in the living body, only by the resistance arising from the rigidity or incompressibility of the parts opposed to them ; or, in other words, the force of elasticity in the cellular and membranous textures is not in a state of neutrality, but the equilibrium is maintained only by the mechanical circumstances of situation. Thus it happens that, when these circumstances are altered, and the equilibrium disturbed, elasticity comes into play and produces a shrinking of the whole mass. The result is that, in the natural state, every part is kept on the stretch ; but retracts as soon as its elasticity is allowed to act by the removal of the extending cause. This will happen whenever the contents of hollow organs are withdrawn, whenever the parts themselves are divided transversely by a cutting instrument, and also when, by a change of position, their extremities are brought nearer together, and the mass assumes a more rounded figure. This property, the result of a high degree of unbalanced elasticity, has long been known, though described under various names. The term by which it has most frequently been designated is that of *tone* or *tonicity ;* but Bichat, who has given a good description of its effects, denominated it "contractilité de tissu" and "contractilité par défaut d'extension," whilst he regards tonicity as another and distinct property not of a mechanical, but of a vital nature. The observations we have formerly made on the vital properties, will show that we regard the distinction which he here makes as being founded on very questionable grounds.

SECT. IV. *The Integuments.*

1. *The External Integuments.*

Integument in general.

(176.) The skin, which gives covering to the whole body, together with its various prolongations and parts connected with it, and constituting altogether the *integuments*, are complex structures. They consist, in the first place, of ordinary cellular tissue ; secondly, of the same substance in a more condensed and membranous form ; and, thirdly, of a stratum of adipose substance ; but they also present us with a kind of structure which differs totally from any of those we have hitherto had occasion to notice. For the clear understanding of these distinctions, it will be necessary, first to explain in greater detail the composition of the external integuments, or the skin.

Structure of the skin.

The parts of which skin consists are arranged in layers ;

and in giving an account of these we shall take them in an order the reverse of that in which they are usually considered; beginning with the innermost layers, and proceeding successively to the more external.

Cutis vera, or corion.

(177.) That portion of the integuments which is called *the true skin*, is in most parts of the body separated from the subjacent muscles or bones, by a stratum of fat, or rather of adipose substance; that is, as we have already seen, of a cellular and vesicular structure, containing the minute globules of the fat. In other parts, the attachment of the skin is effected merely by interposed common cellular substance, of more or less thickness and density in different places. The succeeding layer is that which forms by far the largest portion of the integuments, and has been denominated *the corion*, or the *true skin*. Its ultimate structure is described by Haller as being analogous to that of membranous parts; that is, composed of a dense intertexture of short fibres and of plates, artificially interwoven together, and united by the close adhesion of their surfaces. It may in this view, therefore, be considered as merely a denser tissue of the common cellular substance, which is, in fact, the basis of most animal structures. This density increases gradually as we trace the texture from the inner to the outer parts; while at its interior surface it passes gradually into the looser cellular texture which is beneath it. Bichat gives a similar description of the essential structure of the corion, but states that, in addition to this, there are found a great number of dense fibres, of a whiter colour than the rest, interspersed throughout its substance, which pass in all possible directions, so as of themselves to compose a close net-work, and leave certain interstices or *areolæ*. This reticulated texture, with the interposed vacuities, may be discovered by long-continued maceration, which loosens the adhesion of the fibres. Small masses of fat are found occupying the intervals between them. Thus the dense fibres of the corion may be regarded as the chief support or skeleton, as it were, of the whole fabric, giving it its requisite form, consistence, and other mechanical properties.

Corpus papillare, and papillæ.

(178.) The external portion of the corion is more finely organized than the rest. It has been considered as forming a distinct layer of the skin, named by Bichat, from the large proportion of minute blood-vessels it contains, the vascular net-work; and by other anatomists, *corpus papillare*, from its presenting on its outer surface, when viewed with the microscope, an immense number of little eminences or conical projections, which have been termed *papillæ*. These papillæ were discovered by Malpighi, and have been since described and delineated by Ruysch, Albinus, and many other anatomists. Cheselden and others, however, have doubted their existence, at least as a necessary appendage of the corion; for papillæ are perfectly visible to the naked eye on the upper surface of the tongue, where they are presented on a very large scale. They are also easily perceived, with a magnifying glass, at the tips of the fingers, as well as in other organs endowed with a peculiar sensibility to impressions of touch. But in those parts of the body which have not the same sensibility, and are seldom employed as the vehicles of touch, they are so minute as scarcely to admit of detection; and their existence has been inferred rather from analogy than from distinct and positive observation.

Rete mucosum.

(179.) The external surface of the corion, or of the corpus papillare, is covered with a thin layer of a soft substance, which has been termed the *Rete Mucosum*. It was first observed by Malpighi, in the skin of the negro, and is hence often called after him the *Rete Malpighianum*. The structure, and even existence of this membrane have given occasion to much controversy. Malpighi had announced it as being a stratum of soft matter, disposed in the form of lines which crossed one another in various directions. Blumenbach and other anatomists describe it as merely a thin layer of pulpy matter, without any distinct reticulated structure. Bichat, on the other hand, denies altogether its existence as a proper membrane, and supposes that what Malpighi saw and described is merely a collection of very delicate vessels, which, after having passed through the corion, form a network on its surface. In this opinion he is supported by other anatomists of high authority, as Chaussier and Rudolphi. Mr. Cruickshank,[1] on the contrary, who has bestowed great pains on the examination of this subject, entertains no doubt of the existence of the rete mucosum, both in the external skin, and also even in some of its productions in the interior of the body. Dr. Gordon admits of the presence of the rete mucosum in the skin of the negro, where it is easily demonstrated; but asserts that it cannot be found in that of the European. On the whole, the positive evidence in favour of the real existence of this membrane appears to preponderate; and at any rate, it seems admitted on all hands, that the colouring matter of the skin, which is black in the negro, and has different tints in the other varieties of the human race, is situated in that part which has been assigned as the seat of the rete mucosum. By some it has been stated that the rete mucosum extends in a uniform layer over the whole surface of the true skin; by others that it is perforated in various parts by the papillæ of the corion, and exists only in the interstices of these papillæ.

Cuticle o
epidermi

(180.) The outermost layer of the skin is the *cuticle* or *epidermis*, which gives a uniform covering to every part of its surface, adhering closely to it, and being accurately applied to all its inequalities. It adheres with considerable tenacity to the subjacent skin, through the medium of the rete mucosum, and its attachment is perhaps also secured by fibres passing from the one to the other. In the dead skin a separation is easily effected by maceration in water, and by a state of incipient putrefaction. In the living body the cuticle is detached by the operation of a blister, or by scalding water, which produce an effusion of serous fluid on the outer surface of the corion. As the cuticle is impervious to this fluid, it is raised, and gives rise to a permanent vesicle.

(181.) When the cuticle is carefully separated from the corion, after its connexion has been loosened by putrefaction, a multitude of very slender transparent filaments are seen, stretching between these two layers, which are torn asunder when farther extended. Dr. William Hunter believed these filaments to be the terminations of those vessels which exhale the perspiration, and nearly the same views have been entertained with regard to their nature by Bichat and by Chaussier. Cruickshank, on the contrary, considered them to be processes from the cuticle, and not vessels.

(182.) Many erroneous notions have at different times prevailed with respect to the intimate structure of the epidermis. Leeuwenhoeck conceived that it is composed of a number of laminæ, or scales, which he represented as having an imbricated arrangement, that is, overlapping each other successively, like the scales of a fish. But it is now generally admitted that this was a deceptive appearance. The division of layers, which it may seem to admit of in parts where it is of unusual thickness, is merely an artificial separation, not warranted by any natural distinction of textures. Although some have pretended to discover in it a congeries of vessels, especially lymphatics, yet the most accurate and unbiassed observers declare that they cannot perceive in the epidermis, a specific texture of any kind or any regular arrangement of its parts. Dr. Gordon gives it as his decided opinion that it is "truly inorganized, and non-vascular."

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[1] *On Insensible Perspiration.*

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(183.) Leewenhoeck imagined also that he could discern a number of perforations, or pores, as he termed them, in the cuticle. But later and more scrupulous inquirers have looked in vain for these supposed pores; and it is now generally admitted that none such exist. Indeed, one of the most characteristic properties of the cuticle is its impermeability to fluids, under ordinary circumstances. The latest inquiries into this subject are those of Mr. Chevalier, who describes the cuticle as composed of an infinite number of small *velamina*, regularly arranged, so as to form a bibulous and exquisitely hygrometrical covering.[1] The mode in which the occasional transmission of fluids through this substance takes place in cutaneous absorption, and perspiration, will be the subject of future discussion. The only real distinguishable pores in the cuticle are those which give passage to the hairs, and to the sebaceous follicles hereafter to be noticed.

Thus, then, there is presented to us in this layer of the integument, a kind of structure differing essentially from either the cellular or membranous tissues which have already been described. The epidermis is an animal texture, nearly homogeneous in its substance, possessing but a moderate degree of extensibility, and approaching to the nature of an inorganic substance, inasmuch as it exhibits no appearance of vascularity, and a total absence of nerves, or other medium of connexion with the living system. Bichat even considers its vitality as exceedingly obscure; he doubts whether it can be said to possess life; but is inclined to regard it as a semi-organized, or rather inorganic body, placed by nature at the point of communication between external dead matter and the living skin, and serving as a gradation between them.

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(184.) The nails and the hair are to be classed as structures very similar to the epidermis, of which, indeed, they are often regarded as mere appendages. The nails, in particular, have so intimate an adhesion to the epidermis, that both are generally detached together, by maceration. They consist of hard, transparent, and semi-elastic plates, formed of a substance analogous to the horns of animals. They adhere to the subjacent corion, (which is in those parts furnished with a great abundance of minute blood-vessels, and of which the papillæ are arranged in longitudinal and parallel rows, very close to one another,) in a manner similar to that in which the epidermis adheres to the corion in other parts. The internal surface of the nail is soft, pulpy, and marked with longitudinal grooves corresponding to the lines which they cover and enclose; and by this mutual adaptation the connexion between them is extremely intimate. The innermost edge of the nail is received into a groove formed of a duplicature of skin fitted for its reception. The epidermis belonging to this portion of skin is folded back upon it, and on arriving at the root of the nail, quits the corion, is reflected over the external surface of the nail, and becomes identified with its substance.

The nails, in all their mechanical properties, correspond to the cuticle, and may be regarded as the same substance in a greater state of condensation.

Ha

The hair consists of slender filaments, which appear to be formed of nearly the same substance as the nails, and may be considered, in a mechanical point of view, as still more condensed forms of cuticle. Each hair is provided at its root, with an expanded portion, or bulb, from which its extension proceeds, and which, by the intervention of its vessels, connects it with the corion, in which it is imbedded, just as the roots of a vegetable attach it to the soil. The strength of hair is exceedingly great, compared with its small diameter, as has been frequently ascertained by trying the weights which it can support without tearing. There is no substance, indeed, which would be better adapted for making ropes than human hair, provided it could be procured of sufficient length. It scarcely possesses any extensibility, and is consequently inelastic. If exposed to moisture, it imbibes a certain quantity of water; and this absorption is accompanied with an increase in the length of the hair. From its having this property, it has been employed by De Saussure as a hygrometer, or instrument for indicating the degree of moisture or dryness of the atmosphere. In order to adapt it to this purpose, however, it requires to be freed from a quantity of oily matter, which it naturally contains, by maceration in an alkaline solution. The colouring matter of the hair is supposed to correspond in its nature, as it does in its appearance, to that which is contained in the rete mucosum of the skin.

Thus we find that there is a very considerable similarity between the hair, the nails, and the cuticle, with regard both to structure, composition, and mechanical properties; and that they may be regarded, when once their formation has been completed, as equally devoid of vascularity, and as possessed of the lowest degrees of organization and vitality; if, indeed, these latter properties can at all be attributed to them.

2. *Of the Internal Integuments, or the Mucous Membranes.*

Mucous membranes.

(185.) The structure which characterises the external integuments, is continued in various places into the internal parts; and is found, with certain modifications, in all those membranes which line the internal surfaces of cavities or channels having an external opening. This is the case with the whole track of the alimentary canal; including the mouth, pharynx, œsophagus, stomach, and intestines. It is exemplified, also, in all the passages of the air in respiration, as the nostrils, larynx, trachea or wind-pipe, bronchia or air tubes, and the air vesicles of the lungs. All those passages which open externally, such as those of the ears, urethra, and vagina, are likewise defended by a lining of mucous membrane.

(186.) Bichat has considered the mucuous membranes as forming a distinct system of structure. Analogous in many respects to the serous membranes, they present, in others, the most marked differences. They agree in their office of affording protection to the organs to which they are attached; and their structure, in as far as it is chiefly resolvable into condensed cellular tissue, is very similar. But as they have to serve the additional office of defending the parts which they invest against the irritating qualities of the substances that may come in contact with them, and which may be either the external air or the food, or extraneous bodies, received from without; or else secretions formed by the internal organs, which are to be conducted to the surface, it was necessary that the fluid which covered them should have properties adapted to this object.

Mucous secretions.

(187.) We find, accordingly, that instead of the watery liquid which exudes from serous membranes, the mucous membranes prepare a secretion containing a large proportion of mucus. Hence a more complicated structure is required in the mucous than in the serous membranes. They are divisible into several layers; that which connects them with the parts surrounding the passage or cavity which they line, is of a denser structure; while the one which forms the inner surface of the cavity is softer, and somewhat pulpy in its consistence. Its surface is beset, in many parts, with numerous minute processes, or *villi*, as they are termed. Villi.

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[1] *Lectures on the General Structure of the Human Body*, p. 133.

These have been supposed to bear some analogy to the papillæ of the corion; and the general correspondence of the structure of the mucous membrane and of the external integuments has been farther pursued in the examination of the fine pellicle which gives an universal covering to the pulpy portion, and which has been assimilated to the cuticle. There can be no doubt that the cuticle belonging to the skin is continued over the membranes which line many of the passages above enumerated, and may be traced for a considerable way in those passages. As we advance farther, this cuticular covering becomes gradually thinner, till it ceases to be perceptible.

Crypts, or follicles.

(188.) But the circumstance which more especially characterises the mucous membranes, is the presence of a number of small cavities, *crypts* or *follicles* as they are called; which have more or less of a spheroidal shape, and which open upon the surface of the membrane by a distinct orifice, or duct of communication. These minute sacs or follicles are themselves lined with an extremely fine cuticular membrane, derived from the general covering of the surface on which they are met with. They are found filled with mucus, and are therefore considered as the sources whence that secretion is principally derived.

(189.) Follicles of a similar structure are found in the various parts of the skin; but the substance which they produce, and which they effuse upon the surface of the skin, is more of an oily, than of a mucous nature. It has been termed *sebaceous matter;* and the small cavities which prepare this matter, are known by the name of the *sebaceous glands* or *follicles.*

Sebaceous secretion.

(190.) Thus it appears, that although the offices of the external integuments of the internal mucous membranes are sufficiently distinct, yet a general analogy exists between them in many points of their structure, sufficient to justify their being arranged under the same order, in a general classification of animal structures.

SECT. IV.—*Muscular Action.*

(191.) Having now considered the system which constitutes the passive instruments of the fabric, it is time that we direct our attention to the active powers which are the sources of motion, and the springs of animation and of energy in the living body.

(192.) As in an extensive system of machinery, economy is best consulted by the employment of a single moving power, such as a fall of water, the impulse of the wind, the current of a river, or the force of steam, so, in the animal economy, nature has provided the muscular power, and applied it in every instance where great mechanical power was required to accomplish the intended object. But before inquiring into the nature of this new animal power, it will be necessary to consider the properties of those organs, the muscles, in which this power appears to reside.

1. *Structure of Muscles.*

Structure of muscles.

(193.) *Muscles* are organs composed of certain fibres, endowed with a peculiar power of contracting in their length, under certain circumstances. These fibres are generally disposed in a parallel direction, and variously united together by intervening cellular substance. The muscular system forms a large proportion of the weight, and certainly the greater part of the bulk of the human body.

Fasciculi of fibres.

(194.) On examining the structure of a muscle, we find the minuter fibres are every where surrounded by a fine cellular texture, which connect them together into bundles, which have been called *fasciculi.* These bundles are connected to each other by coarse cellular membrane, so as to form fasciculi of larger size: these, again, are united together into still larger fasciculi by a still more loose cellular tissue. This system of package is continued until we arrive at large cylindrical bands of fibres, which have been termed *lacerti*, and which, being applied laterally to each other, and covered by a general investment of membrane, compose the entire muscle. The fasciculi, as well as the cellular membrane, are coarser in some muscles than in others. Thus they are thicker in the large muscles of the limbs, than in the delicate muscles appropriated to the eye, and other organs of sense. The structure which has now been described is easily discovered in a portion of muscle which has been cut transversely, and then boiled for some time, or macerated in alcohol.

Ultimat structur Observ- tions of Leewen eck.

(195.) Physiologists have not contented themselves with these general views of the structure of muscles, but have been solicitous to ascertain the nature and dispositions of the ultimate fibres to which muscles owe their characteristic properties. The microscope has been resorted to for this purpose; but the success of those observers who have trusted to this instrument in establishing any certain facts, has by no means corresponded with the diligence and zeal with which they have engaged in the inquiry. We find in this, as in many other subjects where the appearances resulting from the employment of very high magnifying powers are the objects of research, that the greatest discordance prevails among the accounts given by different observers. Leewenhoeck, who was one of the first who applied the microscope to the investigation of the intimate structure of organized bodies, but who was too often led away from the truth by the ardour of his imagination, describes the ultimate muscular fibres, or those which admit of no further mechanical division without a separation of their substance, as being almost inconceivably minute. He states them to be many thousand times smaller than a fibre which would only be just visible to the naked eye. He represents them as cylindrical in their shape, and parallel to each other, but pursuing a serpentine course. He remarks that they are of the same figure in all animals, although differing considerably in their diameter in different animals, and that without any relation to the size of the animal. He observed, for example, that the fibril of the frog was larger than that of the ox.

Of Muy

(196.) Muys, a Dutch anatomist, who was engaged for a period of twenty-five years in the most laborious researches on this subject, arrived at a very different result from Leewenhoeck; for he concludes that the real ultimate fibrils of muscles are in all cases, even when the comparison was extended to animals, exactly of the same size.

Of Pro chaska.

(197.) Among the more modern anatomists, Prochaska[1] has bestowed the greatest care in the examination of this subject; and his account has every appearance of being entitled to our confidence. He states expressly that the muscular fibrils are not all of the same diameter, but differ in different animals, and even in different parts of the same animal. Each individual fibril, however, when carefully separated from all extraneous matter, is of uniform thickness throughout its whole extent, and perfectly continuous, even in the longest muscles, from one end to the other. He confidently asserts that they are solid; and instead of being cylindrical, that they have a prismatic, or polyhedral shape, generally flattened, or thicker on one side than on the other; a transverse section of the muscle thus presenting the appearance of basaltic columns in miniature. Their diameter is stated to be about the fiftieth part of that of the globules of the blood. Their surface was found to present a number of depressions or wrinkles; a circumstance which gives them a serpentine appearance. These transverse lines he attributes to the numerous blood-vessels, nerves, and membranous bands which cross the fibrils at different points.

Of Ho Swamm dam,

(198.) According to Hooke and Swammerdam, the musowper, uart, relli, and ntana.

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[1] *De Carne Musculari.*

cular fibrils are composed of a series of globules. Other physiologists, such as Cowper and Stuart,[1] whose observations appear to have been influenced by preconceived theories, imagined that they were cellular. Borelli,[2] who was also biassed by his favourite hypothesis, believed them to be composed of a series of rhomboidal vesicles. The Abbé Fontana[3] in general agrees with Prochaska in his representation of muscular fibrils. He remarks that they are furnished with transverse bands at regular intervals, and that they may always be distinguished by their parallel disposition from the fibres of membrane, which are more or less contorted.

Carlisle.

Sir Anthony Carlisle[4] states that a muscular fibre duly prepared, by washing away all adhering extraneous substances, and viewed by a powerful microscope, appears to be a solid cylinder, the covering of which is a reticulated membrane, and the contained part, a dry pulpy substance, irregularly granulated, and of little cohesive power when dead.

Bauer, wards,

(199.) Mr. Bauer,[5] who is one of the latest authorities on this subject, represents the ultimate muscular fibrils, as composed of a row of globules, exactly corresponding in size to those of the blood when deprived of their colouring matter; that is, about the five-thousandth part of an inch. By long maceration in water, he finds that the mutual cohesion of these globules is loosened, and the fibre is consequently broken down and resolved into a mass of globules. The general results of Mr. Bauer's observations were confirmed by various observers in France, such as Dr. Edwards, and by Messrs Prévost and Dumas, Béclard and Dutrochet.

Hodg. Lister, Skey.

(200.) On the other hand, the more recent, and apparently accurate researches of Dr. Hodgkin and Mr. Lister,[6] and subsequently those of Mr. Skey,[7] have clearly shewn that the supposed globular structure of the muscular fibre is a mere optical deception, arising from deficient defining power in the microscope employed; and that the fibre is continuous throughout its whole length, and sometimes marked by transverse striæ, which occur at intervals much smaller than the diameter of the fibre itself. They have also pointed out this circumstance as constituting a remarkable distinction between the muscles of voluntary and those of involuntary motion, with regard to this striated structure; for it is only the fibres of the former which are characterized by innumerable very minute, but clear and fine parallel lines, or striæ, which cross the fibre transversely. Mr. Skey concludes from his researches, that these fibres in man have an average diameter of one four-hundredth of an inch, and that they are surrounded by transverse circular striæ varying in thickness, and in the number contained in a given space. He describes these striæ as constituted by actual elevations on the surface of the fibre, with intermediate depressions, considerably narrower than the diameter of a globule of blood. Each of these muscular fibres, of which the diameter is one four-hundredth of an inch, is divisible into bands or fibrillæ, each of which is again subdivisible into one hundred tubular filaments, arranged parallel to one another in a longitudinal direction, around the axis of the tubular fibre which they compose, and which contains in its centre a soluble gluten. The partial separation of the fibrillæ gives rise to the appearance of broken or interrupted circular striæ, which are occasionally seen. The diameter of each filament is one sixteen-thousandth of an inch, or about a third part of that of a globule of the blood. On the other hand, the muscles of involuntary motion, (or as Bichat would term them, of *organic life)* are composed, not of fibres similar to those above described, but of filaments only; these filaments being interwoven with each other in irregularly disposed lines of various thickness, having for the most part a longitudinal direction, but forming a kind of untraceable net-work. They are readily distinguishable from tendinous fibres, by the filaments of the latter being uniform in their size, and pursuing individually one unvarying course, in lines parallel to one another. The fibres of the heart appear to possess a somewhat compound character of texture. The muscles of the pharynx exhibit the character of the muscles of voluntary motion; whilst those of the œsophagus, the stomach, the intestines, and the arterial system, possess that of the muscles of involuntary motion. The determination of the exact nature of the muscular fibres of the iris, presented considerable difficulties, which Mr. Skey was not able satisfactorily to overcome.

2. *Muscular Contractility.*

(201.) The proper muscular fibre is so completely surrounded by cellular membrane, and is of so small a diameter, that it is scarcely possible to determine with accuracy its physical properties, independently of those of the tissue in which it is imbedded. The contractile power with which it is endowed, can be studied only as its effects are exhibited by collections of fibres, such as those which constitute the muscles; although in these it must obviously be combined with the elastic power of the cellular texture entering into its composition.

Muscular action.

(202.) It will soon be evident, however, that the property by which the muscular fibre is eminently characterized, is that of suddenly contracting in its length, and thus of bringing the two ends of the muscle, and the parts to which those ends are attached, nearer to each other. This contraction is produced with astonishing quickness and force, overcoming considerable resistances, and raising enormous weights. It is generally the effect of the will of the animal to move the parts to which the muscle is attached; but it may also be excited by other causes. The agent which thus produces muscular contraction is called a *stimulus.*

Stimuli.

(203.) Under the appellation of stimuli, are included many things which seem scarcely to have any property in common, except that of acting upon the muscular fibres, either directly, or through the medium of the nerves which supply them. The contact of many bodies will produce this effect by mere mechanical impulse, independently of any other quality they may possess. Whatever occasions a mechanical injury to the texture of the muscle or nerve, or an actual breach of substance, such as the puncture, division, or laceration of the fibres, will immediately excite muscular contraction. This effect also results from the application of any substance exerting a chemical action on the part; a class of stimuli which comprehends a great variety of agents, such as acids, alkalies, and most of the salts which they form by their mutual combinations, as also the earthy and metallic salts, alcohol, the volatile oils; and above all, oxygen, either in the form of gas, or when contained in substances that part with it readily. Even water itself seems to have some corrugating power when it is applied directly to the muscular fibre; its action, however, is much increased by minute quantities of salt which it may hold in solution. Thus it is found that hard water promotes the contraction of the muscles of fish that have been crimped more than fresh water; and a similar difference of effect is often observed in boiling meat in soft or in hard water.

(204.) But besides these, there are several of the vegetable and animal products which, when applied to the body, produce muscular contraction by an agency which cannot clearly be traced to any chemical property they possess. This class of stimuli includes a variety of substances which are denominated *acrid*, and others which are called *narcotics*, because when largely applied they destroy altogether the power of contraction, and soon extinguish life. As an example of this latter class, we may take opium and hydrocyanic acid.

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[1] *Dissertatio de Structura et Motu Musculari.*
[2] *De Motu Animalium.*
[3] *Sur les Poisons.*
[4] *Philosophical Transactions* for 1805.
[5] *Ibid.* for 1818, p. 164.
[6] Appendix to Dr Hodgkin's translation of Dr. Edwards' work, "*De l'Influence des Agens Physiques sur la Vie.*"
[7] *Philosophical Transactions* for 1837, p. 371.

(205.) Some particular muscles have a disposition to be acted on more especially by particular kinds of stimuli. Each stimulus applied to the body generally, appears to exert a particular influence upon certain parts of the system which are predisposed to be affected by it, while on other parts it appears to be wholly inert. Thus emetic substances act principally on the stomach, even when applied to a different part of the system; and cathartic substances act specifically on the intestines. The muscular fibres of the heart are more particularly excited to contraction by the influx of blood into the cavities of that organ; and, in like manner, every system of muscular fibres concerned in carrying on the vital functions, has a specific disposition to be affected by its appropriate stimulus.

(206.) All the muscles which move the joints of the limbs, and the several parts of which the skeleton is composed, together with several muscles attached to the softer parts, such as the eye, tongue, and throat, are excited to contract by the stimulus of the will, and are therefore called *voluntary muscles.* They compose a class by themselves, as distinguished from those muscles which are not under the control of volition, and which are therefore involuntary muscles, such as the heart, stomach, intestines, and blood-vessels. The nature of this distinction, and of the different laws under which each class of muscles act, will be afterwards pointed out, when we come to treat of the physiology of the nervous system.

Relaxation

(207.) The natural state of a muscle, or that in which it exists when not acted upon by any external cause, is relaxation. When contracted, its surface, from being smooth, becomes furrowed, its middle portion swells out, and grows exceedingly hard and firm, while the extremities are drawn nearer to each other, so that the muscle is now both thicker and shorter than it was before.

Change of specific gravity.

(208.) It has been frequently made a question whether the increase of thickness exactly compensates for the diminution of length. This point might be determined by ascertaining whether the specific gravity of a muscle undergoes any alteration during this change. Glisson had inferred from some experiments which he had made on this subject, that the bulk of a muscle is, on the whole, diminished when it is in a state of contraction. Sir Gilbert Blane,[1] on the contrary, inferred from experiments which he made on fishes confined in a glass vessel with a very slender neck, that the absolute bulk, and of course the specific gravity, of their muscles remains the same whether they are contracted or relaxed; for the level of the water in the narrow stem of the vessel was observed to be unaffected by the muscular exertions made by the fish. Mr. Mayo, by an experiment of this kind on the heart of a dog, found the bulk of that organ unchanged during its contraction or relaxation.[2]

Exhaustion

(209.) The long-continued, or frequent application of a stimulus to a muscle, tends to impair its power of contracting, or, in other words, to exhaust its irritability. This liability to exhaustion is exemplified by all the muscles that are under the controul of the will. We cannot continue to exert the same muscle, or set of muscles, with the same degree of power beyond a certain time, however strong may be the motive to continue that action, and whatever mental effort we may make to persevere. If, for example, we extend the arm in a horizontal line, with a weight held in the hand, we shall find, in the course of a few minutes, that the source of fatigue becomes intolerably acute; and the arm at length drops from mere exhaustion, in spite of every voluntary effort.

Elongatio

(210.) The contraction of a muscle ceasing on the removal of the stimulus that produced it, relaxation succeeds, and the muscle becomes again elongated; not, however, in consequence of any inherent power of elongation, but from the operation of causes which are extraneous to it. The elasticity of surrounding parts is often sufficient to produce this effect; but in most cases the elongation of the relaxed muscle is the consequence of the action of other muscles, which produce motion in a contrary direction. Almost every muscle has another corresponding muscle, or set of muscles, which are antagonists to it. If the one, for instance, binds a joint, the antagonist muscle unbinds or extends it; and by this action must elongate the former muscle.

(211.) The swelling of the muscles of the limbs, when they are in strong action, is matter of familiar observation. It is this circumstance, above all others, which renders a knowledge of anatomy so essentially necessary to the painter and the sculptor. In every attitude and in every movement of the body some particular set of muscles are in action, and consequently swelled and prominent, while others are relaxed and less conspicuous; and unless these differences were accurately noted and faithfully expressed, it would be impossible to give a correct representation of the living figure.

Variatio in the di position the fibres

(212.) Although the fibres which compose the smaller portions of a muscle are arranged in parallel directions, yet the disposition of the mass of fibres, relatively to the whole muscle, varies considerably according to the action which the muscle is intended to perform. We find them, in some cases, radiating from, or converging to a particular point; and sometimes we even find that the different portions of a muscle having this structure can act independently of the rest. The temporal muscle is an instance of a muscle of which the fibres converge from the circumference to a central point, where they are inserted into the coronoid process of the lower jaw. In other cases the fibres composing the muscle pass in a circular direction so as to close upon some organ which they surround, or to compress the bodies they enclose. Thus the eye and the mouth are closed each by a circular or orbicular muscle. In other parts, muscles of this description are called *sphincters.* Some parts, as the iris, are provided with both radiating and circular fibres, the one used for dilating, and the other for contracting the central aperture. We meet with a circular arrangement of muscular fibres in the coats of the various pipes and canals of the body, such as the blood-vessels generally, and also the alimentary passages; and together with these circular fibres are also often found bands of longitudinal fibres, which shorten the tube, while the former tends to contract its diameter, and press upon its contents. The several hollow receptacles for fluids, such as the heart and the stomach, present us with a still greater complication in the arrangement of their muscular fibres, in which we may sometimes trace layers of fibres having a spiral course.

Sphincte

Tendon

(213.) But it very frequently happens that the action of a muscle is wanted when its presence would be exceedingly inconvenient. The common medium of connexion employed by mechanicians, when the object to be moved is at too great a distance to admit of the direct application of the power, is that of a rope or strap. In the animal machine the same purpose is effected by means of tendons, which are long strings attached at one end to the muscle, and at the other to the bone, or part to be moved. If the muscles by which the fingers are bent and extended, for instance, had been placed in the palm or back of the hand, they would have enlarged that part to an awkward and clumsy thickness, which would not only have destroyed the beauty and proportion of the organ, but have impeded many of its uses as an instrument. They are therefore disposed at the arm, even as high up as the elbow, and their tendons pass along the joints of the wrist, to be affixed to the joints of the fingers they are intended to move.

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[1] *Phil. Trans.* for 1805, p. 22, 23.

[2] *Anatomical and Physical Commentaries*, p. 12.

(214.) The employment of tendons also reduces the space which would have been necessary for the direct insertion of the muscular fibres in a bone, so that the same bone may be acted upon in a great variety of ways, by means of the tendons attached to it proceeding from a great number of muscles.

nniform
scle.

(215.) Another advantage resulting from the employment of tendons is, that by their intervention a great number of fibres are made to act in concert, and their united power is concentrated upon one particular point. In this respect, also, they resemble a rope, at which a great number of men are pulling at the same moment, by which means their combined strength is brought into action. These tendons are variously disposed with respect to the muscular fibres to which they are attached. It is but in a few muscles that the fibres are arranged in a perfectly longitudinal direction. We often find them covered on both sides with a tendinous investment, the muscular fibres proceeding obliquely from the one to the other. This arrangement forms what is called a penniform muscle, which may be either single or double. The structure is frequently even more complex than this, a number of tendinous layers being interposed among the fleshy fibres. By means of tendons a different direction may also be given to the moving power, without altering its position. There are many instances of this employment of tendons, in which they are made to pass through a loop, which serves as a pulley, an expedient which is adopted in one of the oblique muscles of the eye.

(216.) We have already seen, that wherever friction takes place by the motion of tendons over bones, or other hard parts, a bursa mucosa is interposed, which obviates in a great measure the injurious effects that would otherwise result from the rubbing of the parts.

chanical
tations

(217.) But although it be true that the force with which muscles contract is very great, yet the extent to which they are capable of exerting that force is in general very limited, and would be insufficient for most of the purposes their contraction is intended to serve, unless it were very considerably enlarged by mechanical expedients. In the practice of mechanics we find a variety of contrivances had recourse to for attaining this object; namely, the production of a great extent of motion, by a power acting through very limited space. But most of these devices would not answer in the human body, from the inconvenience which would attend their application. We find that nature has solved this problem in the simplest possible manner. In the first place, the tendons are inserted into the bones they are designed to move, very near to the centres of motion, so that a small extent of contraction in the muscle will produce a great range of motion at the other extremity of the limb. The principle is here obviously that of what mechanicians have termed a lever of the third class, namely, that in which the power is applied at some point intermediate between the fulcrum and the weight to be raised, or resistance to be overcome. Secondly, the direction of the power so applied, with reference to the line connecting the point of application and the centre of motion, or what is termed the radius of rotation, is oblique; that is, it forms with it an acute angle. Here again we may perceive another cause of the increase of motion, obtained by a smaller extent of contraction above that which would have resulted if the power had been applied at right angles to the radius of rotation, which is obviously the most advantageous mode of employing that power, when the object is to economise it, by giving it the greatest mechanical advantage. It must happen, indeed, by such a disposition of the force, that a large portion of it is lost, being spent on a fixed obstacle, namely, on the bone of the joint, against which the pressure is exerted; but the quickness and velocity of the motion that results are undoubtedly increased. Thirdly, the muscular fibres are themselves obliquely disposed with respect to the tendons, so that the same cause operates in a similar manner here also. Lastly, pairs of muscles are placed so as to form an obtuse angle with one another, and are made to contract at the same time. Their actions, therefore, will partly concur, and partly oppose one another. They will conspire to produce a movement in the parts to which their extremities are attached, in a direction intermediate to that of the muscles themselves; for it is a fundamental law of dynamics, that when a body is urged by two forces inclined to each other at any angle, it will move as if it were urged by a force in the direction of the diagonal of a parallelogram, having for its sides lines corresponding in their direction and their lengths to the directions and relative intensities of the two component forces.

Loss of
force.

(218.) In all these cases it is evident that there must be a great loss of force; but when the muscular power is concerned, we almost always find that strength is sacrificed to convenience, and that construction adopted which unites in the whole the most advantages. We must allow, that the muscular power is turned to the best account when it is made to perform in the completest and quickest manner the intended motion. We find, in following the mechanism not only of the joints of the limbs, but of the whole system of organs, both internal and external, that the mode in which this force is applied is diversified in every possible way. Its combinations are varied, and its action modified beyond calculation, though the original power be still essentially the same, and observes the same laws in its action.

Source of
muscular
power.

(219.) The source of that enormous mechanical power which seems to be an inherent property of the muscular power, has long been sought for by physiologists; but it has always continued to elude their most patient and laborious researches. It was at one period a favourite subject of speculation to devise hypotheses as to mechanical arrangements of particles capable of producing results similar to those of muscular contraction. Borelli[1] conceived that each muscular fibre might be composed of a series of minute bladders, or vesicles, of a rhomboidal figure. Stuart supposed that these vesicles were round. But on either hypothesis they were conceived to be empty, while the muscle remained in its natural state of relaxation. On the sudden introduction of a fluid of some kind into these vesicles, their sides would be separated, they would become distended, and assuming a more spherical form, would consequently be shortened in their longitudinal diameter; and as this shortening would take place simultaneously in all the vesicles, the whole muscle would be contracted in its length, and at the same time proportionally dilated in its breadth. The contrivance had certainly the merit of ingenuity, inasmuch as it explained the swelling of the muscle as well as its shortening, in the act of contraction. But it evidently will not bear the test of serious examination. No such structure as is implied in the hypothesis has ever been rendered visible to the eye, however dexterously the microscope may have been applied to the muscular fibre; nor can we find any power sufficient to propel so large a quantity of fluid as would be required for the distension of the vesicles; an effect also which, in order that the theory may correspond with the phenomena, must be produced almost instantaneously The resistance that would be opposed to the entry of a fluid so propelled would be incalculable, and incomparably greater than that exerted by the muscle itself, which latter force, it may be observed, it is the professed object of this theory to explain. The hypothesis itself, therefore, on which the theory is built, involves a greater difficulty than the simple fact. Such, indeed, was a very common mistake in the speculations of the earlier philosophers, who were ever prone to theorize without having any legitimate basis for the formation of a theory; their foundations being often more in need of support than the superstructure they attempted to raise upon it. It reminds us of the Indian fable of the world being carried on the back of an elephant, whilst the elephant was supposed to require a tortoise for its own support.

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[1] *De Motu Animalium.*

(220.) The hypothesis that the fibres of muscles have a spiral shape, and pass in a contorted line from one end of the muscle to the other, like the turns of a corkscrew, a form which readily admits of elongation or contraction, according as it is more or less contorted, is quite as unsatisfactory as the former; and equally open to the fundamental objection, that it leaves the original source of motion still unexplained. Muscular power, indeed, does not appear, from what we hitherto know of its laws, to bear any close analogy to any of the other great principles in nature, which we recognize as original sources of mechanic force; and until such analogy can be traced, all our endeavours to explain the phenomena of muscular contraction must be fruitless.

(221.) It was a favourite notion with the physiologists of the seventeenth century, that an effervescence was excited in the interior of the muscle, by some chemical operation; such as a mixture of acid and alkali. Willis and others ascribed muscular contraction to a fermentation occasioned by the union of the particles of the muscle, with a supposed nervous fluid, or ethereal spirit contained in the blood.

(222.) But in fact, the only power in nature to which irritability can be compared in the quickness and suddenness of its variations, as well as in its dependence on peculiar qualities of matter, is electricity, and more particularly that form of electricity which constitutes galvanism. Attempts have accordingly been often made, since the phenomena of galvanism have engaged so much attention in the philosophic world, to explain muscular contraction by means of this principle; and endless have been the fanciful hypotheses invented for this purpose. Each muscular fibre was at one time considered as performing the office of a separate Leyden jar, charged with opposite electricities on its exterior and interior; whilst the filament of nerve which penetrated into its substance was the conducting wire, that occasioned the discharge of the jar. After the discovery of the voltaic pile, it was immediately conceived that an arrangement corresponding to the plates of the pile, existed among the particles of nerve and muscle, thus composing a galvanic apparatus, ready to discharge itself when the proper communications were effected. The latest hypothesis of this kind, is that of Prévost and Dumas, who conceived that the muscular fibre was thrown, during its contraction, into serpentine flexures, in consequence of the attractions of electrical currents, passing in similar directions through minute filaments of nerves, the directions of which were at right angles to the axis of the fibres. But in the present state of the science, all these analogies are far too vague and remote to serve as the foundation of any solid theory.

(223.) It has been the fashion among some physiologists to consider muscular contraction as only a particular mode of attraction, and as included in the general law of attraction which subsists among all the particles of matter; but this is a generalization totally unwarranted by the phenomena. Others have maintained that contractility is to be ascribed to the attraction of life, and to be merely a modification of vitality. Thus, Girtanner imagined that this property resided even in the living fluids, and was co-extensive with organized nature. This, however, is equivalent to the assertion, that the phenomena requires no explanation at all; for it certainly leaves the question just where it was before. We already knew that the effect of muscular power indicated a peculiarity to the nature of that power, for they appeared different from any other. To say that it is a peculiar modification of the power of life, gives us therefore no new information, unless it be meant that it is similar in its nature to the other powers which the living organs exhibit; but it would, in that case, convey an erroneous idea, because, the phenomena themselves being different, cannot, according to the rules of legitimate induction, be ascribed to the same physical cause. We have already pointed out the fallacy of this mode of reasoning, in which final causes are confounded with physical causes, and substituted for them as philosophical explanations of phenomena.

Cohesiv force, an tonicity.

(224.) There is, unquestionably, a greater degree of cohesion in the particles which compose the fibres of muscles in their living, than in their dead state. This cohesive power, in consequence of the connexions of the muscle in the body, is equivalent to a constant tendency to contraction. Hence, the fibres of muscles are in a constant state of tension, like an elastic substance kept upon the stretch. This property, evidently derived from contractility, has been denominated *tonicity*, a term which has also, as we have seen, been applied to the peculiar state of tension of cellular and membranous structures, derived from a particular condition of their elasticity. (See § 175.) It produces the state of *tone* in a muscle; or that in which it is disposed to contract to a greater degree, than its connexions with the neighbouring parts will allow. This explains why, on cutting a muscle across, the cut edges retract to a considerable extent, leaving a wide gap at the place of section: when, by a sudden effort, the tendo achilles is ruptured, the muscles in the calf of the leg to which that tendon had been attached, being released from this stretching force, retract to a great extent, and form a large and hard swelling high up in the leg.

Tremulo action of muscles.

(225.) On minutely examining the phenomena of muscular contraction, it will be found, even in those instances in which the contractile power appears to be exerted with undiminished vigour for a certain time, that each individual fibre undergoes, during the interval, a succession of changes of condition, contracting and relaxing alternately. It is only a certain number of the fibres that are in action at the same moment; their power is soon exhausted; and until recruited by repose, other sets of fibres are thrown into contraction, so as to supply their place. They thus relieve one another in succession, until by frequent action the exhaustion becomes more general, and the restoration less complete. In this state, the whole muscle is fatigued, its contractions become irregular and unsteady in proportion as they are more feeble, and the whole action is tremulous, and incompetent to the production of the desired effect. These tremulous movements are very obvious when the muscles are weakened from any cause, as well as when exhausted by excessive action. Dr. Wollaston[1] with his usual acuteness, detected, by a very simple experiment, the minute oscillations consequent upon these continual and rapid alternations of contraction and relaxation in the fibre. When the finger is inserted in the ear with a moderate degree of force, and the pressure is continued with as much steadiness as possible, a peculiar vibratory sound is heard, similar to that of a carriage rolling on the pavement. This must evidently proceed from a corresponding vibratory action of the muscular fibres. It appears, therefore, as Dr. Wollaston remarks, that the voluntary effect in this case, although it may seem to us to be perfectly continuous, consists in reality, of a great number of vibrations repeated at extremely short intervals.

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[1] *Philosophical Transactions* for 1810, p. 2.

(226.) There is a peculiar kind of contractility possessed by membranous structures, which has often been supposed to bear an analogy to muscular contractility, or even to be some modification of this property. It is called into action by the application of a certain degree of heat, and also by some powerful chemical agent, such as the concentrated mineral acids; and the effect produced is a sudden corrugation, or curling up of the membranous part. This phenomenon was noticed by Haller, and was termed by Bichat *racornissement.* Alcohol, and many of the neutral salts produce, but more slowly, effects which are similar in kind, though much inferior in degree; but in this case the corrugation continues to increase, if the agent continues applied, which does not happen when the more powerful agents, as the acids, or boiling water are employed; for the continued operation of these latter agents is to dissolve and disorganize the animal substance. Bichat took considerable pains to investigate these phenomena, and has pointed out[1] several circumstances by which this property may be distinguished from mere membranous elasticity. From muscular contractility, indeed, it differs much more considerably, and depends, therefore, in all probability, on principles totally different from that remarkable animal property.

Sect. V.—*Functions of the Osseous Fabric, or Skeleton.*

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(227.) The general basis for the mechanical support of all the softer organs of the body, both in their states of quiescence and of motion, is the osseous fabric, or *skeleton;* composing a connected frame-work of solid and unyielding structures, fitted for the threefold purposes of giving protection to the more important organs which perform the vital functions, of sustaining the weight of the several portions into which the body may be conceived to be divided, and of furnishing fixed points of attachment to the muscles or moving powers, and thus supplying them with the mechanical advantages of levers in the execution of the more powerful movements of the frame, and especially in the progressive motion of the whole body from place to place.

(228.) The organs more especially defended from external injury by a bony covering, are the *brain,* the principal organs of the *senses,* and the organs of *circulation and respiration.*

1. *The Cranium.*

ctions e sk.

(229.) The bones of the skull are contrived with singular artifice and skill to afford protection to the brain, an organ, as we have seen, of peculiarly soft and delicate texture, and of which the functions are so refined as to require for their accomplishment the most perfect freedom from external pressure, and even from any harsh vibration or concussion of its parts. It is evidently with this view that the bony covering of the brain, or skull-cap, as it has been called, is constructed in the form of a vault or dome, as being the best calculated to resist external pressure, on the well-known mechanical principle of the arch. But pressure applied vertically to an arch necessarily gives rise to an outward horizontal thrust at the two ends of the arch. In architecture, various expedients are resorted to for opposing this force. In a bridge it is resisted by the solid abutments where the arch takes its rise on each side. In the higher arches of ornamental architecture it is counteracted by the weight of a buttress placed over the origin of the arch, and in harmony with the design of the whole. For the support of the roof of a building, which has to rest upon perpendicular walls, either these walls must be built of a strength equal to withstand this horizontal pressure, or, what is generally resorted to, a tie-beam must be attached to the base of the roof, which tie-beam will resist by its cohesive strength the force which tends to stretch it, derived from the outward pressure of the roof.

(230.) In the architecture of the skull we find the exemplification of these methods, and their strict conformity with the refined principles of mechanics. The two parietal bones on the sides, the frontal bone before, and the occipital bone behind, may be considered as the four great stones which compose the convex part of the dome. If we first consider the parietal bones, viewing them as constituting a single arch, we find that their lower edges are bevelled off at an acute angle, so as to be overlapped on each side by the upper edge of the temporal bone, which continues the curvature as far as the basis of the skull. Thus the two parietal bones are effectually wedged in between the two temporal bones, and any pressure applied on the top of the head, which would of course tend to thrust their lower sides outwards, is resisted by the temporal bones. But these temporal bones are themselves locked into the irregularly-shaped sphenoidal bone, which, as we have seen, forms the central piece of the basis of the skull, being in actual contact with every one of the bones which compose it, as well as the face, in which the organs of all the senses, except that of touch, is contained. The os sphenoides thus performs the office of a great tie-beam to the lower part of the arched roof of the skull: and the same principles will be found to hold good when the section of the skull is taken in the longitudinal direction; the os frontis before, and the os occipitis behind, which sustain their share of any pressure made on the upper parts of the head, being so locked in, by the bending inwards of their lower processes, with the sphenoid bone, as effectually to prevent their starting outwardly.

(231.) Another circumstance in the architecture of the skull is particularly deserving of notice, as it exhibits the most marked instance of provident design. It relates to the structure of the bones themselves, which is that best calculated to resist fracture on the one hand, and on the other to prevent the transmission of vibrating concussions to the brain. It is manifestly with this view that it is composed of two plates of bone, the external one fibrous, tough, and not easily broken; the inner one more dense and rigid, offering the most poweful resistance to simple direct pressure; yet, on that very account, more fragile in its nature, and partaking therefore in the quality of brittleness, which belongs to all the harder bodies, such as glass or flint. It was on account of its possessing this property that it was named the *tabula vitrea* by anatomists. But while it is evident that such an accident would have been of frequent occurence if that part of the bone had been directly exposed to every casual blow, this evil has been carefully guarded against by the interposition of a spongy intertexture of bony fibres, the *cancellated structure,* as it is termed, which forms a thick layer between the two laminæ of bone, or as they have been called, the outer and the inner *tables* of the skull. This intervening layer operates as a cushion, arresting the progress of the vibrations from the external to the internal plate of bone, and preventing fracture.

(232.) Even when the impetus is so great as to penetrate through this resisting medium, still the force with which it impinges on the subjacent parts must be very considerably moderated, and the danger of injury to the brain diminished. It is with a similar design of giving protection that a soldier's helmet is lined with leather or covered with hair; a provision which we even find in the head-piece of the Roman soldiers, in whose equipment utility alone was consulted, and nothing was admitted that served the purpose of mere ornament. Wherever the bones of the skull are more particularly exposed to blows, we find a greater thickness of bone provided for the sake of additional power of resistance.

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[1] *Anatomie Générale.*

(233.) The *sutures*, or joinings of these bones, are also admirably contrived to stop the transmission of vibrations arising from percussion from extending to any distance round the skull. These sutures, externally, where the tough and fibrous plates of bone are united, present a serrated line; the fibres at the edges of each being mutually inserted between those of the contiguous bone. But this dove-tailed joining is not met with in the inner table; there the edges of the bone are smooth and placed in simple contact. This is evidently done in order to prevent the chipping off of the minute parts of a brittle structure, had they been interlaced together as the fibres of the outer table are. But still the interruptions afforded by the suture tends in a great degree to check the progress of fracture.

2. *The Face.*

Protection given to the organs of the senses.

(234) The organs of the principal senses, the eye, the ear, the nostrils, and the mouth, are protected by the bones of the face, which likewise form part of the skull. The eyes are exceedingly well defended by the superciliary ridge of the frontal bone above, and also by the orbital plate which supports the anterior lobes of the brain; anteriorly they are protected by the projection of the nasal bones, and outwardly by the arched process which divides them from the temples: while the prominent cheek bones below guard them from injury in that quarter. No part of the body has so effectual a protection from bone as the internal organ of hearing: nor is there any part of the osseous system so hard as the portion of the temporal bone in which this organ is lodged. The nasal cavities, in like manner, which are occupied by the membranes receiving impressions from odorous effluvia, are formed in deep recesses of bone. The organ of taste is also protected by the jaws, though less completely, because the same parts are required to enjoy extensive power of motion.

3. *The Thorax.*

Framework of the chest.

(235.) The heart and lungs, which are lodged in the cavity of the thorax, are defended before and behind by the spine and sternum; and laterally by the ribs, which form bony arches, the shape best calculated for resisting pressure applied externally. They are formed of separate pieces, with intervals between, in order to admit of motion: for the cavity of the chest requires to be alternately enlarged and contracted in the performance of respiration, which is a function of primary importance in the animal economy.

4. *The Spine.*

Functions of the spine.

(236.) The support of the trunk and upper parts of the body, including the head, is entrusted to a column of bones, the assemblage of which constitutes the spine. The spine is that part of the skeleton of all animals composing the four superior classes, namely, the mammalia, birds, fishes, and reptiles, which is most constantly found, and which exhibits the greatest uniformity of structure. The individual bones which compose the spine are so intimately united and so firmly secured by ligaments on every side, that they appear in the living body as one continued bone, and the whole assemblage is known, in ordinary language, by the name of the *back-bone.* The purposes answered by this complex fabric are numerous and important. It is the great central beam of the fabric, and furnishes the basis of support to all other bones of the skeleton. It serves, in particular, to unite the bones of the limbs with the trunk, so that they form with the latter one connected frame-work. It is the axis of their principal motions, the common fulcrum round which they all revolve. It has an intimate mechanical relation with all the parts of the body. It affords attachment to the great muscles which move the trunk and the principal joints of the extremities. It contains and gives protection to that important organ, the spinal cord, from which, as we have seen, almost all the nerves of the body take their origin, and which is unquestionably, next to the brain, the most essential organ in the economy. Whilst the spinal column performs these offices, it is at the same time capable of considerable flexion, both laterally and longitudinally; and admits also of some degree of twisting motion, in a plane perpendicular to its axis.

(237.) No where has art been more conspicuously displayed than in the construction of an apparatus adapted to fulfil such opposite and apparently imcompatible functions. To secure the firmness and strength which are required in the basis of support to the whole body, in the key-stone, as it were, of its various arches, whilst it is at the same time rendered capable of so great a variety of motions, objects which seem utterly at variance with its also affording protection to a tender and delicate organ, in which the least pressure would be attended with fatal consequences, must be allowed to be a most difficult problem of mechanism. And yet these various, complicated, and apparently inconsistent offices, we find executed by one and the same instrument. Flexibility is obtained by subdividing it into a great number of small portions, each of which is separately allowed but a small degree of bending upon the next; and thus a considerable motion is obtained in the whole column, with but a very inconsiderable one at each joint. Each bone, as was described in the account of its anatomy, is connected with its neighbour by a broad basis of attachment; and the slight relative motions of which they are susceptible are chiefly entrusted to the lateral articulations. Whilst these broad bones give the whole chain its requisite firmness and stability, they are so constructed as to afford a passage, without any diminution of their strength, to the substance of the spinal marrow. For this purpose each of the bodies is hollowed out so as to form a continued groove all down the back; and over this groove a broad arch is thrown from each side, converting it into a complete canal. In order to preserve the continuity of this canal, and prevent the vertebræ from shifting upon one another so as to press upon the spinal cord within, during the various movements of the body, further securities are provided. They are severally connected together by their projecting processes, which lock into one another, and are still more firmly secured by the ligaments that bind them down on every side. Thus, the bodies of the vertebræ are guarded against the danger of accidental slipping, but they are defended also from displacement by any force short of what would break the bone.

(238.) But besides all these provisions the vertebral column is protected from injury arising from violent jolts or jars, by having interposed between each adjoining vertebræ, the peculiar springy substance known by the name of the *intervertebral cartilage or ligament;* for it in reality partakes of the nature of both these textures. It is a substance quite peculiar to this part of the frame. Its compressibility and the elastic force with which it recovers its shape when relieved from the compressing power, must greatly lessen the quantity of motion required of each bone during the flexion of the column, as well as soften all the concussions incident to violent motion. No chasm is left by their separation when the spine is bent; and the unity of the whole column, and of the channel in its centre, is preserved unbroken. A passage is at the same time allowed between each contiguous vertebræ for the nerves which issue in pairs from the spinal cord, to distribute their branches and filaments to every part of the body.

(239.) The natural curvatures in the line of the vertebral column also contribute materially to the elasticity of the whole framework. On receiving any shock in the direction of its length, the impulse, instead of being propagated the whole length of its line, is diverted from its course and taken off by the flexures of the column; and the maintenance of its natural position is effected more by the power of the muscles attached to the spine, than by its inherent elasticity.

5. *The Pelvis.*

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(240.) The broad expansion of bone which extends on each side of the pelvis, and the extremities of which form the hips, are evidently designed as a basis of support for the viscera of the abdomen. The lower portion of the bones of the pelvis is at the same time rendered light by being formed into several arches; strengthened at the points where it is exposed to the greatest pressure, and at the same time affording room for the articulations of the thigh bones.

6. *The Limbs in General.*

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(241.) The third office of the skeleton is to furnish levers for accomplishing the progression and other movements of the body, which require great force, great extent, and great precision of motion. These objects are attained by the limbs, which, as is well known, are divided into separate portions, obviously for the purpose of increasing the facility of adaptation to a great variety of movements and of actions which the individual may be called upon to perform.

(242.) The principal bones of the extremities have the shape of lengthened cylinders, and compose a system of levers adapted to the regular and accurate application of the moving force, and for the execution of rapid, extensive, and powerful movements. The circumstance of their hollow and cancellated structure is a palpable instance of provident adaptation to the office for which they are framed. It may be mathematically demonstrated, that if the quantity of materials assigned for the construction of the bone be given, there is no mode in which those materials could have been more advantageously disposed for resisting a transverse force, that is, a force tending to break it across, than the form of a tube, or hollow cylinder, which is that actually given to them by nature. If, for instance, the same quantity of matter had been collected into a solid cylinder of the same length, it would have been subject to fracture by a much smaller force than that which it bears without injury in its actual tubular form. This remark was long ago made by the elder Dr. Monro,[1] who observes that the resistance opposed by a body of cylindrical shape to a force applied transversely is in the direct ratio of its diameter; hence the same number of fibres disposed round the circumference of a circle in such a way as that their sections would present the appearance of a ring, will resist with greater force than if they had been united at the centre, so that their section would present a circle of much smaller diameter than the ring. The hollow cylindrical bones are accordingly found in those situations where the power of resisting external force is principally wanted, while it is at the same time an object of importance not to add unnecessarily to the weight. A simple experiment will illustrate in a very striking manner this proposition. Let a cylindrical glass rod and a glass tube be taken of the same length and also of the same weight, so that they may both contain the same quantity of materials. If each be then supported at their two ends, on a frame adapted to the purpose, it will be found that the same weight which, when hung from the rod, will break it asunder, will, when transferred to the tube, be sustained without even bending it in any sensible degree. Dr. Porterfield has given an elaborate mathematical demonstration of the general proposition.[2]

(243.) There are few subjects in physiology which present so many interesting points of inquiry, or afford more abundant proofs of intelligence and design than the mechanical properties of the osseous fabric. From the account we formerly gave of the composition of bone, it appears that it is constructed of two principal materials, an earthy basis, which is the phosphate of lime, and an animal or membranous substance, which possesses considerable tenacity. To the first of these ingredients the bones owe their solidity and hardness. No inorganic matter, not even the metals, has so great a cohesive power, with a given weight of materials, as the earthy bodies; and this is probably the reason why the phosphate of lime has been selected as the substance employed to give the necessary solidity and hardness to bones. But these qualities, if carried to excess, would be accompanied with brittleness. To guard against this evil, the cohesion of the inorganic earth is tempered by the interposition of an elastic organic material; this is the cellular tissue, within the cells of which the bony matter is deposited, and which acts the part of a cement, binding them more strongly together, and at the same time obviating the excessive brittleness which a substance of more uniform hardness would have possessed. Thus, by the admirable blending of these two elements, two qualities which, in masses of homogenous and unorganized matter are scarcely compatible with one another, are happily united.

Articulations.

(244.) The manner in which the cylindrical bones are connected together is also highly deserving of attention. There are, indeed, few parts of the mechanism of animals more peculiarly fitted to excite our admiration than the structure of the joints. Every provision seems to have been made for facilitating their motion, and every precaution taken to enable them to act with safety. Their ends are enlarged for the purpose of affording a broader surface of junction, and for procuring greater firmness and security of connexion. The rough and hard substance of bones would have been particularly exposed to injury if they had been allowed to grate upon one another without some intervening smooth surface. In all the joints, at the places where the ends of the bone would have suffered from this cause, we find them tipped with a white, smooth, and elastic cartilage. Dr. Paley[3] has very aptly compared this expedient to the plating of a metallic instrument with a different metal. Detached portions of cartilage, are, as we have seen, frequently placed between the bones, which thus, instead of working upon each other, work upon the intermediate cartilages. This is analogous to the contrivance practised by mechanics, who interpose a loose ring where the friction of the joints of any of their machines is great, and who particularly resort to it where some strong and heavy work is to be done. It is precisely under similar circumstances that the same contrivance is employed in the human body; and the analogy is a striking evidence of that art and foresight which are manifested in the plan of its conformation. The lubricating quality of the synovia is also an exquisite provision designed to diminish friction.

(245.) The ligaments which bind the ends of the bones together, and restrain the direction of their motions, are admirably calculated to perform the offices assigned to them. Like the bones, they unite qualities which are rarely met with in conjunction. They have all the properties we can desire in a rope; namely, perfect flexibility, with great power of resisting extension. It is hardly imaginable how great a force is required to stretch, or rather to break asunder a ligament, for it will not yield in any sensible degree until the force is increased so as at once to tear it to pieces. Yet with all this toughness, it is so flexible as to oppose no impediment to the suppleness of the joint. "Every joint," says Dr. Paley, "is strictly a mechanical instrument, and as manifestly contrived, and as accurately defined as any that can be produced out of a cabinet maker's shop. Their durability is no less astonishing. A limb shall swing upon its hinge, or play in its socket, many hundred times in an hour, for sixty years together, without diminution of its agility."[1]

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[1] *Anatomy of the Bones and Muscles*, p. 21.

[2] *Edinburgh Medical Essays*, vol. i. p. 95.

[3] *Natural Theology.*

7. *The Lower Extremities.*

Mechanism of the lower extremities.

(246.) The three portions into which the lower extremities are divided, namely the *thigh*, *leg*, and *foot*, being united by joints, and moveable upon one another, are calculated to serve the double purpose of firm columns of support to the body while standing, and of facilitating and regulating its movements while advancing. It might, on a superficial view of the subject, be supposed that, in standing in the erect posture, the weight of the body would be more firmly and effectually supported had the whole limb consisted of a single straight column. But independently of the greater strain to which such a structure would be exposed, in consequence of the great length of bone required, it would, in fact, have had less stability than it now possesses. A marble statue of a man resting merely on the feet in a natural attitude, would be overthrown by a small impulse; and even in the living body, it is an infallible consequence of the laws of mechanics, that if ever the perpendicular line drawn from the centre of gravity happen to pass beyond the base of support, the body must inevitably fall in spite of every muscular exertion that can be made. The only way to prevent such an accident is to bring back the centre of gravity nearer to a point above the centre of the base before it has actually passed it; and this we instinctively do when we feel ourselves in danger of falling to one side, by extending the arm horizontally on the opposite side.

Act of standing.

(247.) But the limb being divided into joints, these joints would give way under the weight of the body, were they not prevented from bending by the constant action of the muscles. The continual muscular effort required in standing is nearly as great an expenditure of muscular power as the act of walking. Soldiers on parade remaining in the same attitude, experience even more fatigue than they would suffer by a march during an equal time, because the same muscles are constantly in action. The posture of a soldier under arms, with his thighs and legs in the same straight line, is one which requires a painful effort to preserve. The moment the word of command is given him to "stand at ease," the muscles on one side immediately relax, the right knee is slightly bent, the tension of the ankle-joint is relieved, and the body, sinking upon the left hip, has its height diminished by above an inch and a-half. The weight of the trunk is sustained more directly by the column of bones of the left limb, which support that weight at a greater mechanical advantage than before; for the oblique direction of the neck of the thigh bone, with regard to the bones of the pelvis, which is very great in the perfectly erect position, is now diminished. But the great source of relief is that a different set of muscles is called into play on every change of posture; those which were before fatigued have time to recruit their energies, and become prepared afterwards to afford in their turn the same relief to others by resuming their exertions.

(248.) Strictly speaking, it is quite impossible for even the strongest man to remain for even a very short interval of time in precisely the same position. The fatigue of the muscles which are in action soon become sensible, and relief is instinctively given to them by varying the points of support. Thus we may observe that in standing, the weight of the body is naturally thrown alternately from one foot to the other. The action of standing must be considered as a series of perpetual, but obscure movements, by which the centre of gravity is continually shifted from one part of the base to the other; the tendency to fall in any one direction being perpetually counteracted by small and insensible movements in the contrary direction. Long habit has rendered us unconscious of these exertions, and inattentive to the sensations which prompt them. But a child, when acquiring the art of walking, is sensible of all these difficulties, and does not learn to walk but by reiterated lessons, and by the experience of many falls. It is by a practice of the same kind, and continued during a longer period, that the rope-dancer learns to support himself on a narrower or more unstable base than that which nature has provided. This he effects, not by keeping his centre of gravity precisely in the mathematical perpendicular to the rope, but by continually shifting it from side to side; never allowing it to fall above a certain very minute distance, and immediately correcting the vacillation by a movement which gives it an impulse in the contrary direction.

(249.) The flexures of the joints of the lower extremities, it may be observed, take place alternately in opposite directions. Thus, the thigh is bent forwards upon the pelvis; the leg is bent backwards upon the thigh; and the foot, again, is bent forwards upon the leg. This arrangement is obviously the one best adapted to convenience, both as regards the folding the parts when bent, and the commodious disposition of the muscles, which perform the opposite motions of flexion and extension. As the weight of the body occasions the flexion of the joints, so it is that flexion which the muscles are chiefly required to counteract; and this is the duty of the extensor muscles. We accordingly find, that in each joint, the latter are much larger, and more powerful than the flexors. They are enabled also to act with greater mechanical advantage, in consequence of their being inserted into projecting processes of the bones, evidently provided with this express intention. This is the purpose of the trochanter of the thigh bone, and the projecting bone of the heel. The same object is accomplished, in a still more artificial manner, in the knee-joint, by an additional bone, the *patella*, or knee-pan, into which the great extensor muscles situated in the fore part of the thigh are inserted, and which renders their action much more efficient, both by diminishing its obliquity, and by removing it farther from the centre of rotation. It acts, therefore, as a pulley, which is a species of lever; and it is so contrived, that while the knee is bent, and the muscles at rest, as when we are sitting, this bone sinks down, concealed in a hollow of the knee. When the extensor muscles begin to act, they draw out the patella from this hollow; and in proportion as they contract, and their strength diminishes, the patella gradually rising, gives greater mechanical advantage to their action, which is greatest of all when, by their complete contraction, their power is most expended.

(250.) The structure of the feet is also admirably contrived, as a secure basis for the support of the whole superincumbent weight of the body, and of all the additional burdens which the body may be made to sustain. The arrangement of the bones is in as strict conformity to the principles of the arch as those of the skull. The bones of the tarsus constitute what may be called a double arch; that is, an arch in two different planes, at right angles to one another. There is, in the first place, one great longitudinal arch, springing from the point of the heel to the ball of the great toe: and there is, in the second place, a transverse arch formed among the tarsal bones themselves, one within another. Near the heel this arch is composed of the astragulus, os calcis, and naviculare; and farther on, by the cuneiform or wedge-like bones, the name of which expresses their office, analogous to that of the stones at the crown of an arch of masonry. The elasticity, as well as security, resulting from all these arches, imparts that ease and spring so remarkable in the step, and obviates the injurious jar that would be otherwise inevitably communicated to the body by leaps, by falls, or other accidents.

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[1] *Natural Theology.*

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(251.) In walking, the first action consists in fixing one foot firmly on the ground, by transferring to it the whole weight of the body; the other foot being then at liberty to move, is with the leg carried forwards. This projection of the limb is necessarily attended with a corresponding advance of the centre of gravity, which proceeds to move forwards till it arrives beyond the basis of the foot on which the body is resting. Whenever this happens, the body, being unsupported, begins to fall, and would continue to fall, were not the other foot in advance, and ready to receive it, and stop its further descent. This is the reason why we experience so disagreeable a jar, if in walking inattentively, the foot we had advanced happens to arrive at a lower level on the ground than had been expected; as when, for instance, we meet with a descending step for which we were not prepared. The body on these occasions, falling through greater space than usual, acquires a certain velocity of descent, and this unusual velocity being suddenly checked, commuicates a shock to the whole system.

(252.) While the weight of the body is thus transferred alternately from one foot to the other, the centre of gravity of the body, while it is continually carried forwards, is at the same time alternately raised and lowered, so as to describe at each step a small arch; and its whole motion may be represented by a waving line, having lateral as well as longitudinal inflexions, and composed of a succession of short curves. In taking long steps, we are obliged to raise the centre of gravity through a longer arch, and therefore to a greater height. This is consequently more fatiguing than a shorter step. If, however, we go into the contrary extreme, and take too short steps, the advantage obtained in lessening the height of the arches described by the centre of gravity, is more than compensated by the greater quickness required in the motions necessary for keeping up the same rate of walking.

(253.) The lateral undulation of the body during walking is never performed with precise equality on both sides; and the amount of the accumulated deviations would be considerable, did we not avail ourselves of the assistance of the sense of sight in counteracting it. This will appear from the well-known fact, that it is impossible for a person who is blindfolded to continue to walk in a straight line for any considerable distance. Even on a perfectly level plain, we unavoidably incline to the right or to the left; and the want of consciousness that we are doing so, prevents us from rectifying the error; so that while we imagine we have undeviatingly pursued a straight course, we may perhaps, when the bandage is removed from our eyes, find ourselves near the very spot from whence we had commenced our circumambulatory excursion.

8. *The Upper Extremities.*

Mechanism of upper extremities.

(254.) The upper extremity, though exempt from the office of supporting any part of the weight of the trunk, and intended for a variety of very different uses, presents us with exactly the same number of divisions as the lower extremities; excepting that in the skeleton, if we compare the scapula to the bones of the pelvis, there is an additional bone provided in the clavicle, or collar bone, by means of which the bones of the arm are articulated with those of the trunk. The extremity of the clavicle, indeed, by which it joins the sternum, is the pivot on which all the great motions of the arm are performed. The interposition of the scapula is evidently for the purpose of giving a more extended surface for the attachment of the strong muscles destined to act upon the arm and upper part of the trunk, and which also lend their aid in performing the movements necessary for respiration. It also contributes its share in the defence of the back part of the chest.

(255.) The joint of the shoulder is of the ball and socket kind, and admits, therefore, of the greatest latitude of motion. That of the elbow is a simple hinge-joint, and restricted consequently to mere flexion and extension. A rotatory motion was here unnecessary; for the free rolling of the arm at the shoulder answers every purpose that can be desired, and the elbow-joint is rendered more secure by this limitation of its motion; for it will always be found, that whenever a hinge-joint is sufficient for the purposes required, it is employed in preference to that of the ball and socket, which, from its very extensive range of motion, must necessarily be looser in its structure. and more liable to dislocation.

The hand.

(256.) In the wrist, which is the great centre of all the motions of the hand, a construction was called for which might allow of the utmost latitude of motion. The following were the three kinds of movement required; first, simple flexion and extension; secondly, lateral flexions; and, thirdly, twisting, or rotation of the hand, as when it is employed in turning a screw. If all these different motions had been entrusted to a simple ball and socket joint, they could not have been well performed without great strains and hazard of dislocation. This danger is admirably obviated by distributing the motions among several articulations. No part of the bony system is more complex than the wrist, which consists of eight small bones crowded into a very narrow space, and lashed together by many strong ligaments, that form bands crossing one another in every possible direction. While they are together fitted to the bones of the fore-arm in the manner of a hinge-joint, their mutual connexions allow at the same time of considerable lateral flexion.

(257.) But still the rotatory or twisting motion of the hand, which is perhaps the most useful of all, is not provided for by this mechanism. For the accomplishment of this object there is employed a contrivance to which the rest of the system presents nothing similar. The wrist is connected not so much with the principal bone of the fore-arm, as with a subsidiary bone of equal length with it, and placed in a parallel position, termed the *radius;* and its peculiar mode of junction is such as to enable it to describe round the former a complete semicircle. In these rolling motions the radius carries along with it the hand, which thus turns in perfect security; for it is difficult to conceive how a force could well be applied, so as to separate bones having so long a lever of resistance. Thus, while the wrist is exempt from the weakness incident to circular joints, it possesses all the properties which we find in the most moveable.

(258.) The manner in which the fingers are disposed in the hand, like radii from a common centre, is such as to allow them very free play, and to extend their sphere of action. But the chief perfection of the hand, as a mechanical instrument of prehension, consists in the structure of the thumb, which is furnished with muscles of so great a strength, compared with those of the fingers, as to enable it to oppose and balance their united power. Hence the hand is capable of grasping a spherical body, and of keeping firm hold of a variety of objects, which it would otherwise have required the concurrence of both hands to retain.

(259.) The passage of the tendons, by which the fingers are bent, is particularly deserving of notice, and has often been appealed to as a signal instance of express contrivance. As the uses of the hand require the bending of each joint of the fingers independently of the others, it was necessary that separate muscles and separate tendons should be provided for each. The muscles are most advantageously placed high up in the arm, and convenience requires that those muscles which bend the last joints should lie beneath those that bend the middle joints. Had the tendons proceeding from the latter been directly inserted into the middle of the second bone of the finger, they would have been exactly in the way of the tendons which are underneath, and which are proceeding to a more distant insertion. They are therefore split into two branches, each being inserted into the side of the bone; and the lower tendon is thus allowed to pass on securely between them. This structure has also this further advantage, that it procures a more ready flexion of the last joint than of the other joints; a provision, the purpose of which is manifest, since it tends effectually to prevent the escape of the object we wish to lay hold of. "There is nothing," says Dr. Paley, "in a silk or cotton mill, in the belts, straps, or ropes, by which motion is communicated from one part of the machine to the other, that is more artificial, or more evidently so than this perforation." "Let a person observe his own hand while he is writing, the number of muscles that are brought to bear upon the pen, how the joint and adjusted operation of several tendons is concerned in every stroke, yet that five hundred such strokes are drawn in a minute. Not a letter can be turned without two or three tendinous contractions, definite both as to the choice of the tendon, and as to the space through which it moves. Yet how correctly does the work proceed; how faithful have the muscles been to their duty; how true to the order which endeavour or habit has inculcated. Let us watch the hand while playing upon a musical instrument. All the changes produced, though extremely rapid, are exactly measured, even when most minute; and display on the part of the muscles an obedience of action alike wonderful for its quickness and its correctness."

Uses of the hand.

(260.) To specify all the instances of express contrivance in the mechanical conformation of the hand would fill a volume. As an organ of touch it is admirably formed. No instrument is better adapted to the practice of the mechanical arts; none could be better fitted for examining the properties of bodies, and the laws of the material world, of which none of the other senses, unassisted by that of touch, could impart to us any accurate knowledge. So great are the advantages which the possession of this organ has conferred upon the human race, that many philosophers, prone to paradox, have ascribed to this circumstance alone the whole of the intellectual superiority which he enjoys over the brute creation.

CHAP. VI.—ASSIMILATION.

Sect. I.—*Chemical Constitution of Organized Matter.*

1. *Necessity of Aliment.*

Necessity for nutriment.

(251.) A constant supply of nutritive matter is necessary for the continuance of life, a necessity arising from a variety of causes. In the first place, the substance of which the body is formed is exposed to various sources of waste and dissipation, and is continually verging to a state in which the organs become unfit for the performance of their functions. The chemical affinities by which the elements of organized substances are retained in that peculiar mode of combination which constitutes their living state, are, as we shall presently see, very nicely balanced, and would be unable to preserve them in that condition were not some means provided for counteracting their natural tendency to decomposition. By the active exercise of their respective functions all the organs, but more especially the muscular and nervous systems, experience a deterioration of their component parts, and suffer decay and waste. Fresh materials are required for supplying this continual expenditure. A certain degree of temperature must also be kept up, otherwise the muscles would lose their faculty of contracting, and the nerves their power of conveying impressions to and from the sensorium. Materials are therefore necessary to be employed as fuel for keeping up the vital warmth. The daily consumption of combustible materials, apparently used for this purpose in the animal economy, is, we shall afterwards find, very large, and forms a considerable proportion of the food received into the body.

(262.) All that we have now said refers to the body in its adult or mature state, when it has attained its full dimensions, and when all that is required is its preservation in that state. But during all that period of life when the body is increasing in its size, it is evident that its growth can only take place in consequence of the addition of new particles to those already composing the substance of the body; and some parts, such as the hair and nails, continue to grow even to the latest period of life. At every age some part is liable to be injured or destroyed, and a provision is in most cases made for the reparation of that which has been injured, or even for the replacement of that which had been destroyed. These objects can be effected only by the supply of new materials derived from external sources.

The changes effected by the long series of assimilatory processes being essentially chemical, it becomes necessary to institute a particular inquiry into the chemical constitution of organized substances in their successive stages of mutation, from the most simple to the more complex conditions in which they are found to exist in the composition of an animal body.

2. *Chemical conditions of organized matter.*

Chemical conditions of organized matter.

(263.) The parts, which by their assemblage constitute an organized body, when compared with unorganized matter, exhibit in their chemical, as well as in their mechanical characters, the most well marked and striking contrast. Complexity, variety, and difficulty of analysis, are the leading features as much in the former, as in the latter of these subjects of consideration. Combinations equally artificial, equally the result of design, and of refined elaboration, are exhibited both in the mechanism of organic structures, and also in the chemical constitution of organic substances. Compared with the latter, all the bodies which are presented to us in the mineral kingdom, are extremely simple; and their study presents no difficulties of an insurmountable nature. The number of primary or elementary substances, or of those at least which we regard as simple, is, indeed, greater in the mineral kingdom, than that of those which enter into the composition of animal or vegetable bodies; but they are for the most part found united in binary combinations, or are, at least, easily resolvable into a small number of such binary compounds. In the products of animal or vegetable systems, we find a less variety of ultimate principles; but this is more than compensated by the infinitely greater diversity of modes in which they are combined. The same elements, instead of forming with each other mere binary combinations, generally exist in more complicated states of union; there, four, five, or even a greater number of constituent substances, having their affinities nicely balanced, and harmonized into one individual combination.

(264.) From this diversity in the mode of union, there arise remarkable differences in the properties of different organized products, formed from the same ultimate principles: nor can we, as in bodies belonging to the mineral kingdom, with an exact knowledge of the nature and proportions of the component substances, proceed, by any artificial arrangement, to the actual formation of the compounds themselves. No approach has yet been made by human ingenuity, to the imitation of nature in these refined operations of vitality.

Balance of affinities.

(265.) Another consequence resulting from this difference in constitution between organized products and the inorganic bodies of the mineral kingdom, is that the affinities by which the elements of the former class of bodies are held in union, being nicely balanced, are more subject to change. The equipoise is easily disturbed and subverted. The principles have a constant tendency to react on each other, so as to give rise to a new order of combinations; which readily take place by slight alterations of circumstances. All organic products are susceptible of decomposition by heat alone; they are readily acted upon by various agents, as water or atmospheric air; and they are generally liable to spontaneous changes, to fermentation, and putrefaction.

(267.) Such, then, are the distinguishing features of the chemical properties belonging to the products of organization; simplicity as to the number of ultimate elements; complication in the mode and order of combination; unsteadiness in the balance of affinities retaining them in union, and consequent proneness to decomposition, and impracticability of their artificial formation by a reunion of their principles.

Tr com- pnt ele- ms.

(268.) Whilst the products of the animal kingdom participate with vegetable bodies in these common characters, which distinguish them from inorganic materials, they differ from the former in several subordinate circumstances of chemical relation. The constituent principles of animal substances are somewhat more numerous, and their affinities more nicely adjusted, and more easily disturbed. Their chemical constitution is the result of still more delicate processes, and of a more elaborate organization. The three great component elements of all vegetable bodies, are *oxygen, hydrogen*, and *carbon;* but animal substances generally contain, besides these, a considerable proportion of a fourth element, namely *nitrogen*, the presence of which has a considerable influence on the changes they undergo when subjected to the operation of foreign agents, or left to the spontaneous operation of internal causes of decomposition. *Phosphorus* and *sulphur* must also be enumerated among the component parts of the greater number of animal substances; and the affinities exerted by these elements also tend to modify the results produced by these various causes. The greater the number of elementary ingredients present in any assemblage, the greater will be the tendency to form binary or ternary combinations; and the more will the affinities be divided between different elements, and pass easily from one mode of arrangement into another. Hence the greater susceptibility to decomposition which characterises animal products, when compared with vegetable.

(269.) In addition to the substances already mentioned, we must also reckon among the constituents of animal substances, *lime, potash, soda*, and *iron;* but these exist only in small quantities.

(270.) Some of the most important qualities distinguishing animal substances are owing, in particular, to the predominance of nitrogen in their composition. This substance is disengaged from them in large quantities by the action of the nitric acid. This acid, indeed, itself contains nitrogen; but it has been ascertained, that in producing this effect, the acid does not undergo any decomposition; so that the nitrogen is furnished not by the acid, but entirely by the substance subjected to its action. *Ammonia* is evolved both during the putrefaction of animal substances, and also by the application of a heat sufficient for their decomposition; and this ammonia results from the combination of the nitrogen with hydrogen during these processes. *Cyanogen*, or *prussic acid*, is also a frequent product of these operations; and is known to consist chiefly of nitrogen. Under these circumstances, also, the phosphorus enters into new combinations, particularly with the hydrogen and azote, and forms compound gases, which are extricated both during the putrefaction and destructive distillation of animal substances. By becoming acidified by its union with oxygen, it enters into combination with earths, alkalies, and oxide of iron, and forms a variety of neutral salts. The same observations also apply to the sulphur which is found in certain quantities in several animal substances.

(271.) Another general difference in the chemical composition of animal and of vegetable substances, is that the former contain a smaller proportion of carbon, and a greater proportion of hydrogen than the latter. Carbon may be regarded as the base of vegetable matter, to which oxygen and hydrogen are attached; while hydrogen appears to be the principal component part of animal matter, and is there combined with nitrogen, oxygen, carbon, and phosphorus. Hence during the decomposition of animal substances by heat, the chief products are ammonia and empyreumatic oil, in both of which hydrogen is a principal constituent. In general animal matters contain less oxygen than vegetable, and hence afford less acid by their decomposition; and the coal which remains differs from vegetable charcoal in being much less combustible.

3. *Proximate Animal Principles.*

Proximate principles.

(272.) In the numerous and diversified products of the animal kingdom, we may trace different degrees of complication in the composition of their elements. Several substances present the appearance of greater simplicity, and appear to result from the more direct union of a few elements, and to preserve among various shades of modification the same general properties, and the same distinctive characters. The more compound products often admit of an intermediate analysis into these comparatively simpler constituents, which are distinguishable from each other by a certain uniformity of character, and which we may presume are obtained in the same state as that in which they existed in the compound subjected to the analysis. These form what are termed the *intermediate* or *proximate principles of animal bodies*, in contradistinction to the *elementary principles*, which are the result of the ultimate analysis of the substance. These proximate principles may be considered as forming by their mixture, or combination, all the varieties of animal matter; and they are therefore the more immediate object of attention to the chemist in his analysis of animal substances.

(273.) The only method resorted to by the earlier chemists, in the infancy of science, for ascertaining the composition of animal substances, was that of subjecting them to the process of distillation at a high temperature, by which their proximate principles were entirely destroyed, and either converted into new compounds, or resolved into their ultimate elements. Many of these being gaseous, were suffered to escape, and were totally disregarded. Scarcely any light could be thrown upon the composition of animal bodies by such an imperfect mode of examination. Successive improvements were afterwards introduced into this branch of chemical research, consisting chiefly in the application of various re-agents, from which instructive results were derived.

(274.) The modern art of animal analysis may be considered as comprising three different kinds of operations, which, however, admit of being variously combined. The first consists in observing the spontaneous changes resulting from various natural circumstances in which the substances may be placed; the second depends on the application of chemical agents, employed either as tests to indicate the existence of particular elements or proximate principles, or as menstrua, which, by their specific affinities, may separate the elements or primary compounds from each other; while the third set of operations, reverting to the original plan of destructive analysis, effects the complete decomposition of the substance, but carefully collects all the volatile and gaseous matter, and deduces an accurate estimate of the nature and proportions of the ultimate elements. We obtain, for example, a certain quantity of water, carbonic acid, and ammonia; and knowing the proportions of oxygen, hydrogen, and carbon, which they respectively contain, we are able to ascertain the precise amount and relative proportion of the elements which entered into the constitution of the substance analysed.

(275.) The general result of the investigations which have been conducted by the last of these methods is, that the simple bodies of which animal substances consist are comprised in the following list:

1. Oxygen
2. Nitrogen
3. Carbon
4. Hydrogen
5. Lime
6. Phosphorus
7. Sulphur
8. Soda
9. Potass
10. Chlorine
11. Magnesia
12. Iron
13. Silica
14. Manganese.

(276.) Of these, the first six may be considered as the principal elementary ingredients of animal substances. Magnesia and silica are found only in very minute quantities, and may therefore be in a great measure considered as foreign bodies. The soft parts of the body are composed almost entirely of oxygen, nitrogen, carbon, and hydrogen; while lime and phosphorus form the basis of the hard parts.

(277.) The proximate principles most generally met with in animal substances are,

1. Gelatin
2. Albumen
3. Fibrin
4. Mucus.

(278.) To these have been added some others, such as *urea, picromel, stearin, elain, osmazome*, and several *saccharine* and *acid principles*, which being more limited in their extent, will fall more properly under consideration in the review we shall give of the substances which chiefly contain them. We shall first then present an account of the properties of the four essential principles above enumerated.

4. *Gelatin.*

Gelatin.

(279.) Gelatin may be extracted by long continued boiling in water from almost all the hard and solid parts of the body, such as the skin, membranes, ligaments, cartilages, and even the bones themselves. By the slow evaporation of the water which thus holds it in solution, the gelatin may be obtained in a state of purity, when it appears as a hard, brittle, and semi-transparent substance, which breaks with a glassy fracture. It varies somewhat in its appearance, according to the source from which it has been obtained. Glue may be taken as an example of dried gelatin, in which, however, a few impurities are contained. Isinglass may be considered, on the whole, as the purest form under which gelatin is met with, and it exhibits most completely the characteristic properties of that proximate animal constituent.

(280.) One of the most striking characteristics of gelatin is the property it exclusively possesses, when united to a quantity of water, of dissolving slowly, but completely, forming a solution of an opaline colour, which is perfectly fluid when warm, but becomes concrete on cooling, assuming the tremulous appearance so well known as belonging to jelly. In this state it readily again becomes liquid, by the application of a gentle heat, and may, by the continuance of that heat, be brought back to the state of dryness. These alternate solutions and desiccations may be repeated for any number of times, without any change being produced in the chemical constitution of the gelatin. The proportion in which gelatin forms a solution capable of concreting by cooling, has been ascertained by Dr. Bostock in the following manner. One part of dry gelatin to 100 parts of water gave a solution which completely stiffened by cooling. But when the proportion of water was 150 parts to one of gelatin, a compound was produced, which though evidently gelatinous, did not assume the concrete form.

(281.) Solid gelatin undergoes no change if it be kept perfectly dry; but when united with water, either in the form of solution or of jelly, it very soon becomes putrid; an acid first makes its appearance, a fetid odour arises, and ammonia is afterwards formed.

(282.) The most ready and convenient test of the presence of gelatin in any fluid, is a solution of tannin; the addition of which immediately occasions, by the combination of these two principles, a copious precipitate, which assumes a solid form. This precipitate collects into an elastic adhesive mass, which soon dries in the open air, and forms a brittle resinous-like substance, very similar in appearance to over-tanned leather. It is perfectly insoluble in water, and is not susceptible of putrefaction. It is this combination of tannin with gelatin that constitutes the preservative part of tanned leather, and which enables it to resist the transmission of moisture. The solutions of tannin most conveniently applicable as tests of gelatin, may be prepared by an infusion of an ounce of gall-nuts in a pint of water; or, as Dr. Bostock has proposed, the extract of rhatania, digested in hot water, and filtered after it becomes cold. A considerable precipitate is produced by these infusions, when the proportion of gelatin to the water is so small as to compose only the five thousandth part of the solution. The precipitate afforded by tannin is not, however, to be considered as a decisive test of the presence of gelatin; for, as we shall presently find, it also occurs in consequence of the presence of albumen. In order to prevent any confusion from this cause, it will be necessary to have recourse also to another test, that of corrosive sublimate, which is found to precipitate albumen, but not gelatin. If, therefore, by adding corrosive sublimate, we obtain no precipitate, we may be certain of the presence of albumen.

(283.) Gelatin is insoluble in alcohol, but when already in solution in water, it is not precipitated by that fluid. Acids dissolve it with great facility, even when much diluted, especially when aided by heat. The nitric acid effects its decomposition, during which nitrogen, and then nitrous gas, are disengaged in considerable quantities; and oxalic and malic acids are evolved, and may be obtained from the residuum. Sulphuric acid, with the assistance of heat, partly converts it into a substance resembling sugar. Chlorine combines with gelatin, forming a white substance, which assumes the form of filaments.

The pure liquid alkalies dissolve gelatin very readily. The solution is a brown viscid substance, which possesses none of the properties of soap, and is not precipitated by acids. This property of remaining dissolved after acids are added to the alkaline solution, distinguishes gelatin from albumen, fibrin, and other animal products, and is therefore a valuable mode of discriminating its presence, and of separating it from them in analysis.

(284.) Gelatin is precipitated by several of the metallic salts and oxides, but not so unequivocally as to afford satisfactory tests of its presence. Like all the other constituents of animal bodies, gelatin, while it preserves its essential properties, is susceptible of many shades of variation, and appears therefore under a diversity of forms, such as glue, size, isinglass, &c; but although many valuable remarks on this subject are contained in Mr. Hatchett's *Observations on the Component Parts of Animal Membrane*, published in the Philosophical Transactions for 1800, we are still very much in the dark as to the circumstances which occasion the differences in the several kinds of animal gelatin.

5. *Albumen.*

Albume

(285.) The proximate principle which, from its composing the greater part of the white of the egg has been termed *albumen*, is most abundantly met with in almost all the parts of animals, whether solid or fluid. It is the chief basis of several of the more solid textures of the body, such as the membranous and fibrous structures, and the parenchymatous substance of the glands and viscera; and it also forms a large proportion of the blood and of the secreted fluids.

In the white of the egg, albumen exists in a state of solution in water, and combined with a small quantity of soda. By agitation with a still larger quantity of water, the two fluids unite, and form a viscid liquid, the component parts of which do not separate by standing.

(286.) The characteristic property of albumen is its capability of coagulating, or passing from a liquid to a solid form, by the action of heat, of acids, and of alcohol, and several metallic salts and oxides. This change takes place in undiluted albumen, at a temperature of about 160° of Fahrenheit. After it has been once coagulated, albumen is no longer soluble in water, unless by long boiling, aided by pressure. By a long continued gentle heat, coagulated albumen gradually has its moisture dissipated, and the solid matter, amounting to about one-fifth of the original weight, is left behind, in the form of a hard brittle transparent substance.

(287.) If the albumen be much diluted, it appears to be incapable of coagulation by the usual means; but still it was found by Dr. Bostock, that a solution containing only one thousandth of its weight of albumen, although not properly coagulated, was rendered perceptibly opaque by a boiling temperature; so that heat may be considered, for all practical purposes, as a sufficiently accurate test of its presence in any fluid. During coagulation there is no absorption of oxygen; nor is any gas extricated: and hence there appears to be no reaction of the principles of the albumen upon each other. The nature of the change which takes place during this transition from the fluid to the solid form, is by no means well ascertained. Dr. Thomson supposed the fluidity of albumen to depend on the presence of alkaline matter; and its coagulation to the removal or neutralization of this alkali; and some experiments which were devised by Mr. Brande tend strongly to support this theory. He found that a rapid and abundant coagulation took place in the white of an egg subjected to the action of a galvanic battery, around the negative pole, where the alkali must have been separated; while a thin film only collected round the positive pole. He discovered also, by these experiments, that galvanic electricity may be applied successively to the detection of very minute quantities of albumen, which would not be rendered sensible by any other test.

(288.) Another agent which immediately effects the coagulation of albumen, unless it be previously much diluted, is alcohol. Ether also produces the same effect.

(289.) Acids in general occasion the coagulation of albumen; but several of them afterwards redissolve the coagulum if assisted by heat. This is at least the case with the three mineral acids. The coagulum formed by acids always retains in combination a portion of the acid which has been employed. That produced by nitric acid is the least soluble; and hence nitric acid occasions a precipitate from solutions of albumen, which are so dilute as not to be affected by other acids. Thenard remarks that the coagulum produced by acids, is re-dissolved by pure alkalies, and even by ammonia, which does not dissolve albumen that has been coagulated by heat. Nitric acid, when concentrated, decomposes albumen, extricating from it azotic gas, and during its solution, nitrous gas. Oxalic and malic acids are formed, and a thick oily matter, soluble in alcohol, appears on the surface. On the other hand, when coagulated albumen is subjected to the action of dilute nitric acid, it is after some time converted into a substance having the properties of gelatin. For this highly curious fact we are indebted to Mr. Hatchett.[1] Alum, probably in consequence of its excess of acid, coagulates albumen, provided the solution be not very dilute. One part of albumen in five hundred of water is rendered slightly turbid by a solution of alum, but without any formation of a precipitate.

(290.) The triple prussiate or ferrocyanate of potass is, according to Dr. Henry, an extremely delicate test of the presence of albumen, and may be used to discover it in fluids to which other tests are inapplicable. To enable it, however, to produce a precipitate, a very slight excess of acetic acid should be previously added, either to the test, or to the liquid suspected to contain albumen.

(291.) Another delicate test of the presence of albumen is a solution of corrosive sublimate; and it is the more valuable, inasmuch as it has no effect on solutions either of gelatin or of mucus. Dr. Bostock found that a single drop of a solution of corrosive sublimate added to a liquor containing one thousandth of its weight of albumen, renders it visibly milky, and at the end of some hours a flocculent precipitate falls to the bottom of the vessel. The same re-agent produces a sensible effect on a liquid, containing only half that quantity, or one two-hundredth of albumen.

(292.) Many other metallic salts, throw down a precipitate from solutions of albumen, as the acetate of lead, the nitro-muriate of tin, the nitrate of silver, and the nitro-muriate of gold; but as they produce a similar effect on other species of animal matter, they are scarcely deserving of confidence as tests of any one in particular. A solution of tannin, which, when added to albumen, occasions, after some time, a precipitate, may sometimes afford useful indications in analytical inquiries, for it may be distinguished from that produced from gelatin by its want of density and cohesion.

(293.) Albumen is readily dissolved by the pure liquid alkalies, which disengage ammonia from it, and form with the residue a saponaceous compound. This soap, when dissolved in water, is precipitated by acetic or muriatic acids.

6. *Fibrin.*

Fibrin.

(294.) The proximate animal principle, known by the name of *fibrin*, or *animal gelatin*, exists in large quantity in the blood, and forms the basis of the muscular flesh of animals. When properly prepared, and freed from the admixture of extraneous matter, it presents a substance of a white colour, destitute of taste or smell, of a fibrous texture, and of a soft and elastic consistence. When dried it is brittle, and has a certain degree of transparency; it undergoes no change from the action of either air or water.

(295.) When exposed to heat, it contracts very considerably, and exhibits movements like horn, exhaling at the same time the smell of burned feathers. When subjected to great heat, it yields the usual animal products of water, oil, ammonia, carbonic acid, and carburetted hydrogen, with a large carbonaceous residuum. This charcoal is very difficult to incinerate, owing to the presence of phosphoric salts, which are fused by the heat employed for that purpose, and form a glassy coat on the surface. A considerable quantity of carbonate of lime is found in the residual ashes.

(296.) The acids exert a considerable action upon fibrin. Concentrated acetic acid renders it soft and transparent; and the whole mass is converted by heat into a tremulous jelly. By the addition of water, and the continued application of heat, a complete solution is effected, attended with the evolution of nitrogen. Fibrin combines with muriatic acid in two proportions; the one gives a neutral compound soluble in water; the other, containing an excess of acid, is insoluble, but becomes soluble by the action of pure water. Concentrated sulphuric acid decomposes and carbonizes fibrin. Diluted with six times its weight of water, this acid acquires a red colour by being digested with fibrin, but scarcely dissolves any sensible portion; but part of the acid is absorbed by the remaining mass, which becomes a compound of fibrin and an excess of sulphuric acid. Water deprives it of this excess, and a neutral combination is obtained, which is soluble in water, and has the same characters as neutral muriate of fibrin. The action of nitric acid upon fibrin is much diversified, according to its dilution or state of concentration. When the acid is diluted with a large quantity of water, a great abundance of nitrogen gas is disengaged. This gas is entirely derived from the fibrin, and not from the acid, which, as Berthollet ascertained, has suffered no decomposition during the process. The residuum, in this case, is principally oxalic acid, with a small quantity of malic and acetic acids, and a portion of fatty matter. When the nitric acid is undiluted, on the other hand, it undergoes decomposition, and nitrous gas, mixed with nitrogen gas, is disengaged. When fibrin is digested for twenty-four hours in nitric acid of the specific gravity 1.25, it is converted into a pulverulent mass, of a pale citron colour, which is deposited at the bottom of the liquid. By washing it in water, the excess of acid is carried off, and the colour gradually becomes of a deep orange. Fourcroy and Vauquelin considered this yellow matter to be a peculiar acid, which they distinguished by the name of the *yellow acid.* But Berzelius has shewn that it is merely fibrin combined with nitric and malic acids. When the action of nitric acid on fibrin is very slow, it is gradually converted into a state somewhat analogous to gelatin.

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[1] See his paper already quoted from the *Philosophical Transactions* for 1800.

(297.) Fibrin, when subjected to the action of caustic alkali, increases in bulk, becomes transparent and gelatinous, and at length is entirely dissolved, forming a yellowish green solution. From this solution it is precipitated both by acids and alcohol, but seems to have undergone some change for it is not as before, soluble in acetic acid. Fourcroy had asserted, that the compound of fibrin and alkali resembles soap; but it does not, in fact, appear to have any analogy with saponaceous bodies.

(298.) Alcohol of the specific gravity of 0.81, converts fibrin into a kind of adipocirous matter, which is soluble in alcohol, and precipitated by the addition of water. It has a strong and unpleasant odour. The alcoholic solution leaves, on evaporation, a fatty residue, which did not pre-exist in the fibrin, but which, like the original substance, is soluble in acetic acid. By the action of ether, fibrin is converted into the same kind of adipocire, but which has a more offensive odour, and is in larger quantity.

Analogies between them.

(299.) After the account we have given of the three proximate principles which enter so largely into the composition of animal matter, namely, gelatin, albumen, and fibrin, it will be useful to take a comparative view of the analogies they present, and of the differences by which they are distinguished, both in their properties and composition. They are apparently composed of the same ultimate elements, combined in proportions which are not widely different. They admit accordingly of mutual conversion into one another, by processes which produce a slight alteration in the proportion of their constituents. By the action of the nitric acid fibrin is converted into a kind of gelatin, and a similar change has been effected on albumen by the same re-agent. All these substances are presented both in the liquid and solid forms, and pass readily from the former to the latter of these states, without any apparent change in their chemical constitution. They are all of them indestructible when perfectly dry, but readily undergo putrefaction when united with water. Yet the modes in which they are respectively acted upon by water are different, and affords an easy character of distinction between them. Gelatin is soluble in cold water; the solution when evaporated becomes gelatinous; and if this jelly be dried, it is still again soluble. Albumen is likewise soluble in water; but whenever the temperature is raised to 170°, it separates by coagulation, and this coagulum is not again soluble. Fibrin is clearly distinguished by its total insolubility in water at any temperature, at least under the common atmospheric pressure.

Comparative analysis.

(300.) Then these principles likewise differ in their composition; for though they seem to consist of some ultimate principles of nitrogen, hydrogen, oxygen, carbon, phosphorus, and sulphur, yet these differ somewhat in their proportions. The most accurate analysis of these substances into their ultimate elements are those of MM. Gay Lussac and Thenard, the results of which are exhibited in the following table:

	Gelatin.	Albumen.	Fibrin.
Carbon,......	47·881	52·883	53·360
Oxygen,......	27·207	23·872	19·685
Nitrogen, ...	16·988	15·705	19·934
Hydrogen,...	7·914	7·540	7·021
	100.	100.	100.

It appears from the above analysis, that the principal difference of composition occurs in the proportion of nitrogen. Gelatin contains the least of this element; albumen more; and fibrin a quantity considerably larger than either of the others. The latter substance appears therefore to be the most animalized product. It also contains the largest quantity of carbon, as appears indeed from the greater residuum of charcoal which it leaves after destructive distillation. Sulphur is perhaps peculiar to the composition of albumen. On the other hand, the proportion of oxygen is considerably greater in gelatin than in either of the other two substances. This predominance of oxygen, together with the less compactness of its mechanical composition, are probably the causes of the greater tendency which gelatin shows to pass into the acid fermentation. In this respect also, gelatin shows itself to be less completely animalized than the other proximate principles, and to partake more of the chemical character of vegetable substances, which are well known to evolve an acid in the progress of spontaneous decomposition. There are indeed some vegetables, as the tribe of fungi, that become alkaline by their putrescence; and these are found to contain nitrogen; so that gelatin on the one hand, and the fungi on the other, may be regarded as forming, on each side, the connecting links between these two great kingdoms of nature.

(301.) It is a curious subject of speculation to reduce the proportions resulting from the analysis of the French chemists, to those which are most reconcileable to the atomic theory. They will then stand as follows:

Number of atoms of	In Gelatin.	In Albumen.	In Fibrin.
Carbon,............	15	17	18
Oxygen,............	6	6	5
Nitrogen, ...	2	2	3
Hydrogen, ...	14	13	14

The weights, both absolute and relative, of the atomic elements, are shewn in the following table:

	Gelatin.		Albumen.		Fibrin.	
	Absolute.	Relative.	Absolute.	Relative.	Absolute.	Relative.
Carbon,....	90	50·00	102	53·40	108	52·94
Oxygen,...	48	26·67	48	25·13	40	19·61
Nitrogen,..	28	15·55	28	14·67	42	20·59
Hydrogen,	14	7·78	13	6·80	14	6·86
	180	100·	191	100·	204	100·

In the conversion of albumen into jelly, by the slowly continued action of nitric acid, we may conclude that the acid imparts a portion of its oxygen to the albumen, and perhaps adds also a small quantity of nitrogen; thus constituting the proportions assigned to gelatin by Gay-Lussac and Thenard.

7. *Mucus.*

M s.

(302.) The term *mucus* has been employed in very different senses by different writers. Some have applied it vaguely to almost every animal substance which was not referable to any other class. Fourcroy and Vauquelin, while they include under this term the viscid secretions which lubricate the alimentary and other passages that open at the surface of the body, they have admitted its claim to be considered as a peculiar proximate principle, but regard it as analogous to vegetable gum, from which they suppose it to differ only by containing a proportion of nitrogen. Their descriptive account of its properties, however, are deficient in the precision which the subject seems to require, and which have been aimed at by subsequent chemists. Berzelius, it is true, refuses to allow that there is any such common principle as mucus, and founds his opinion on the ground that the chemical characters of the fluids which bear that name, are very various in different parts of the body, and are modified in different situations, according to the particular purposes they are intended to fulfil. Mr. Hatchett, in his interesting paper on *the Component Parts of Animal Membrane*, has attempted to fix the meaning of the term more definitely. Viewing mucus as extremely analogous in its properties to gelatin, he considers these two substances as merely modifications of each other; the former characterized by its incapability of being gelatinized; the latter by possessing that property; while both are soluble in water.

Dr. Bostock, in his excellent papers on *the Analysis of Animal Fluids*, has endeavoured to establish definite characters as belonging to this fluid, when existing in a state of purity. He states that if the solid matter obtained from the evaporation of saliva to dryness, be re-dissolved in water, and filtered, the solution will consist of mucus alone, or with scarcely any extraneous substance. By a careful evaporation he found that the solution contained one two-hundredth part of its weight of mucus. He also obtained a similar principle by macerating an oyster in water, and evaporating the liquid. It thus appeared that the water had dissolved about one-fiftieth of its weight of animal matter. Mucus thus obtained resembles gum-arabic, excepting that it is somewhat more opaque. Like it, it has scarcely any taste, dissolves readily in water, and forms an adhesive solution. Alcohol added to this solution has no tendency to coagulate it. No appearance of coagulation is produced by exposing the fluid for some time to the heat of boiling water; nor is there any tendency to gelatinize, by evaporating and afterwards cooling the fluid. No distinct effect is produced on the solution of mucus, either by the nitro-muriate of tin, corrosive sublimate, or the infusion of galls. The subacetate of lead, or Goulard's extract, occasions an immediate opacity, and after some time, a flaky precipitate.

(303.) Dr. Bostock concludes that a decided and essential difference is thus established between mucus and jelly, by the different effects produced by tannin, and by subacetate of lead. Tannin is a most delicate test of jelly, but does not in any degree affect mucus. Goulard's extract, on the other hand, is a delicate test of mucus, but does not in any degree affect jelly. The bichloride of mercury, (corrosive sublimate), on the contrary, which is one of the most accurate tests of albumen, does not appear to affect either jelly or mucus.

Notwithstanding the attempts which Dr. Bostock made to devise a method of directly determining the proportion of mucus in a compound fluid, he was not able to succeed, in consequence of the facility with which Goulard's solution decomposes the different extraneous ingredients, both animal and saline, which are almost always present in substances that contain mucus, even in a state the nearest approaching to purity. The salts are particularly liable to act upon the metallic solutions employed as tests; so that it is impossible to say how much of the effect is owing to each of these separate causes. The precipitates thrown down from mucus by subacetate of lead, and nitrate of silver, were found by Mr. Brande to consist both of the muriates and phosphates of those metals. Mr. Brande also attempted to obtain mucus free from neutral salts, by subjecting it to the action of galvanic electricity. He thus detected a small quantity of albumen in saliva, which was not discoverable by the ordinary tests.

(304.) A great resemblance has frequently been noticed between the mechanical properties of animal mucus and vegetable gum; and Dr. Bostock found that they strongly resemble each other also in their chemical qualities. A solution of gum-arabic, containing one grain of gum to two hundred grains of water, was not affected either by the bichloride of mercury, nor by tannin. With the nitro-muriate of tin, and with the nitrate of silver, there was only a slight degree of opacity; but with the subacetate of lead there was a dense precipitate instantly formed.

(305.) On the whole, however, animal mucus in its chemical relations appears to be most nearly allied to albumen; and the constituent upon which its characteristic properties principally depend, would seem, as Dr. Bostock remarks, to be a mere modification of this substance.

Method of analysis.

(306.) We shall conclude our account of this substance by the following direction as to the order in which it will be most convenient to conduct our analytical inquiries of a fluid, which may be supposed to contain either albumen, jelly, or mucus. The first step is to observe the effect of the bichloride of mercury; if this produce no precipitate, we may be certain that the fluid in question contains no albumen. We should next employ the infusion of galls, and if this also occasion no precipitate, we may conclude that the animal matter held in solution consists of mucus alone. Such being the chemical properties of the chief proximate principles of animal organization, we have next to examine the mode in which these substances are produced in the economy.

Sect. II.—*Arrangement of the Functions of Assimilation.*

Reparatory or chemical functions.

(307.) The means provided by nature for meeting the various demands of the system, by converting materials derived from without into the proximate principles of animal organization, the properties of which we have now examined, constitute a separate class of functions distinct from all the others. They might not unaptly be termed the *reparatory functions;* but as the changes which are effected in the materials received into the body for its conversion into nutriment are wholly of a chemical nature, we thought they might, with still greater propriety, be termed the *chemical functions*, in contradistinction to those the objects of which are entirely of a mechanical nature, and which have already passed under our review.

(308.) The reparatory, or chemical functions, may be divided into two great orders; the first consisting of those which effect all the changes that the food undergoes during its conversion into blood; the second, of those which apply the blood, or nutriment thus properly prepared, to the various purposes for which it is wanted, and which effects in it those chemical changes that are required for those objects.

Series of reparatory processes.

(309.) The first order may again be subdivided into several subordinate processes, including, 1st, The preparation which the food undergoes in the mouth by *mastication*, or mechanical division. 2d, Its admixture with saliva and other secretions, which is generally termed *insalivation.* 3d, Its *deglutition*, or conveyance into the stomach. 4th, Its *digestion* in that cavity, and conversion into chyme, which may properly be termed *chymification.* 5th, The subsequent changes it undergoes in the intestines, by the influence of various agents, such as the bile, the pancreatic and intestinal secretions; and its ultimate conversion into chyle, and separation from the excrementitious portion, comprising the processes of *chylification*. 6th, Its *absorption* by the lacteals, its transmission to the heart, and its *sanguification*, or conversion into blood. To the above functions the title of *natural functions* was given by the older physiologists, and the name is retained in many modern works in medicine.

(310.) The second order comprehends, in like manner, a number of most important functions, which, from their immediate influence on the continuance of life, have been emphatically denominated the *vital functions*. They consist, 1st, of the *Circulation* of the blood, by means of the heart, arteries, veins, and capillary vessels. 2d, *Respiration*, by which every portion of the blood is subjected in its turn to the chemical action of the air respired; is freed from its excess of carbon, and becomes oxygenated, or arterialized, and fit to be applied to the purposes of the system. 3d, *Secretion*, a term which expresses a variety of changes effected in the blood, by passing through glands and other secreting organs, adapting it to different purposes in different cases. Closely allied in its object to secretion is the function of (4th) *Nutrition*, whereby the several parts of the body receive accessions to their growth, and are maintained in the condition requisite for the perfect performance of their requisite offices. 5th, *Absorption* by the lymphatics, for the removal of all superfluous or decayed particles in the body. 6th, The last function in this order, which completes the series of chemical changes going on in the living laboratory of the body, is *Excretion*, or the separation of useless or noxious materials from the blood, and their rejection from the system. We shall proceed to the consideration of these functions in the order in which they have been enumerated. But for the proper understanding of the subjects they involve, it will be necessary to premise an inquiry into the chemical nature of the substances which are received into the body as food.

Sect. III.—*Properties of Food.*

Properties of food.

(311.) The food of man is more various in its kind than that of any other animal; for it comprehends a great multitude of articles both of an animal and vegetable nature. Hence man has been regarded as entitled to the appellation of an omnivorous animal. His powers of digestion, however, though capable of being exercised upon a great variety of materials, are yet inadequate to the assimilation of many substances, which form the exclusive food of several of the larger quadrupeds whose structure and economy are not very remote from those of man. The human stomach and intestines are incapable of extracting nourishment from the fibrous or membranous parts of vegetables, like the ox, the sheep, and other herbivorous animals; nor have they the power of digesting hard and solid bones, like the hyæna, the dog, and other highly carnivorous quadrupeds. Neither the leaves of trees nor the grasses, have ever, in any age or country, been used as the food of man. Many savage races of the American continent, though possessing vast tracts of country abounding in trees and grass, have frequently been visited by the extremes of famine, by which whole districts have been depopulated. When Australia was first visited by Europeans, the native inhabitants were found only occupying the sea-coast, gathering up a scanty and precarious subsistence from the shell-fish casually thrown upon the shore; but the settlements which have since been made have occasioned their retirement into the interior, and their numbers have rapidly diminished. It is obvious that, had the leaves of the vegetables which grow wild in those regions been capable of affording the smallest sustenance, they would have necessarily been resorted to in these extremities of hunger. But no authenticated instance of the kind occurs in the history of the human race.

Food of man.

(312.) Man, however, seems to enjoy the exclusive privilege of having organs of digestion equally adapted to the assimilation of both animal and vegetable aliment of certain kinds; and the range which is allowed him in this respect is most extensive. Hence we find, that in most countries where there prevails a high degree of civilization, and where religious scruples do not interfere, both animal and vegetable food is indiscriminately employed by all who can procure them. In many parts of the globe, indeed, necessity compels a restriction to certain kinds of diet; and in some the same restriction is imposed as a religious duty. Thus the Gentoos live entirely on the vegetable produce of the earth, to which, however, they add the highly nutritious article of milk. The Birmans, who are a remarkably active and robust race, are said to live exclusively upon vegetable food. On the other hand, the inhabitants of the mouths of many of the African rivers, live wholly upon the produce of the ocean. The flesh of the rein-deer constitutes the principal food of the Laplander. In general it would appear that the inhabitants of cold climates consume a larger proportion of animal food than those of the torrid zone. Whence it has been, with much probability, inferred, that less combustible matter is required by the system in situations where the external temperature is habitually high; a remark which, if well founded, is conformable to the principle already laid down in our statement of the purposes to which a portion of the food is applied, namely, that of keeping up the animal temperature. In the ruder periods of society, when the arts of civilization had not yet diffused their beneficial influence over mankind, it is probable that men were more carnivorous than in the present state of the world. The introduction of the use of corn, and other grains of the same class, has effected in this respect an important change in the condition of the species; but it would appear that the introduction of this great benefit was very gradual, and must have required a long succession of ages before the cultivation of the gramina had attained any degree of perfection.

1. *Animal Food.*

Animal food.

(313.) The parts of animals which are chiefly consumed as food is the muscular flesh; but milk, and the different products obtained from milk, together with eggs, also compose articles of diet. The animals from which these aliments are derived, are principally the herbivorous mammalia, different tribes of birds and fish, a small number of the class of reptiles, and several species of mollusca and crustacea. The flesh of the mammalia and of birds consists principally of fibrin and gelatin, intermixed also with fat. Milk may be considered as an emulsion of albumen, oil, and sugar, suspended in a large quantity of water. The two former ingredients, when obtained separately, constitute respectively cheese and butter. The eggs of birds chiefly contain albumen, together with a small quantity of oil. Fish contains less fibrin, but a larger proportion of albumen and gelatin than the flesh of either quadrupeds or birds; and in some fish there is joined to these constituents a large quantity of oil. This also is the case with those crustacea and mollusca which are used as articles of diet. When we come, therefore, to analyze the proximate principles from which animal nutriment is derived, we find them reducible to the following: namely, fibrin, albumen, oil, gelatin, and sugar; together with a few others, such as ozmazome, which are of minor importance.

2. *Vegetable Food.*

Vegetable food.

(314.) The parts of vegetables most frequently consumed as food, are the seeds, seed-vessels, fruits, stalks, roots, and tubera, and more commonly the leaves. The most nutritious amongst the proximate principles resulting from the analysis of these vegetable materials, are gluten, farina, mucilage, oil, and sugar. The seeds of the cerealia or of rice constitute the chief bulk of the food in those countries where civilization has made any considerable progress. Of all these kinds of grain, wheat appears to contain, in proportion to its bulk, the greatest quantity of nutriment; and this arises from its abounding in gluten, which of all the vegetable principles appears to be best adapted to the human organs of digestion. In its properties it bears a strong resemblance to animal substances; and it appears, indeed, by chemical analysis, to contain a large proportion of nitrogen. Hence it may be considered as the most animalized of the vegetable products. Gluten is contained in most vegetables which afford farina, and is also found in the leaves of many esculent vegetables, such as the cabbage.

Farina.

(315.) *Farina* is found in great abundance in wheat and other grains, and also forms a large proportion of the nutritive portion of rice, and of certain tubers, among which the principal is the potatoe. The leaves, stalks, and seed-vessels of plants are rendered nutritious by the mucilage which they contain, which is generally united with a portion of sugar.

Sugar.

(316.) The saccharine principle contained in vegetables, and blended with their other elements, contributes greatly to render them nutritious; though in its pure state, as extracted from the sugar-cane, or the beet, it is rather used as a grateful addition to other articles of diet than as a separate source of nutriment. Sugar may be extracted from a great variety of plants besides those above mentioned. The maple, the birch, the parsnip, the cocao-nut, walnut, maize, and carrot, contain it in great abundance, as is the case, indeed, with every species of grain used as food. Almost all fruits are more or less saccharine. Figs, grapes, and dates, which contain it in large quantity, form a very considerable proportion of the food of the inhabitants of the south of Europe, and the African nations on the borders of the Mediterranean. All fruits contain a basis of mucilage, and in many this mucilage is combined with oil as well as with sugar.

Scale of nutriment.

(317.) Attempts have frequently been made to reduce all nutritious substances to a single principle common to all of them, and to establish accordingly a scale of nutriment, the place which any substance should occupy on that scale being regulated by the proportion in which this essential principle existed in it. Haller conceived that jelly might be considered as fulfilling this condition, and as being the essentially nutritive substance in nature.[1] Cullen thought that this property appertains to two substances, the nutritious matter being either of an oily or saccharine nature, or consisting of these two qualities combined.[2] Richerand considers alimentary matter as either gummy, mucilaginous, or saccharine.[3] Dr. Fordyce referred all nutriment to the presence of mucilage.[4] All these, and many other attempts at generalization, made by different physiologists at different times, are premature and unphilosophical, since they associate in the same class substances having properties totally dissimilar, although they concur only in that of affording materials for the support of the animal system. Perhaps the most exact classification of the kind is that of Magendie, who refers all alimentary substances, whether animal or vegetable, to the following heads, namely, farinaceous, mucilaginous, saccharine, acidulous, oily, caseous, gelatinous, albuminous, and fibrinous.

(318.) Prout, in a paper published in the *Philosophical Transactions*,[5] thinks that all the articles of food used by man may, according to their chemical relations, be arranged under three heads, namely, the saccharine, the albuminous, and the oily. Sugar, the basis of the first class of alimentary substances, he finds to consist of carbon in different proportions, from thirty to fifty per cent. chemically combined with water. The basis of albumen and oil are more compound, but are also united with water, the proportion of carbon existing in some of the oils being nearly eighteen per cent. He is of opinion that two at least of these elements must be blended together in our food in order to render it either nutritious or digestible. Milk, the food provided by nature for the young animal, exhibits the most perfect union of these three elements.

Oil.

(319.) It must be evident, however, upon a slight consideration, that notwithstanding all the attempts that have been made to establish an accurate scale of nutriment, more must depend upon the powers possessed by the digestive organs to convert the particular kind of food into nutritious matter, than upon its being able to supply the elements requisite for composing nutriment. Thus there are many substances, such as oil for example, which contain a very large proportion of the elements which compose the blood, but which are extremely difficult of digestion, and consequently cannot of themselves be considered as nutritious, although when blended with other substances which contain fewer of these elements, but which enable the stomach to exert a proper action upon the compound, they become highly nutritive. This remark applies also to sugar, which, although adding considerably to the nutritive qualities of those vegetable products which contain it, would not, if used alone, be capable of supporting life. Magendie found, that dogs fed upon sugar alone soon became unhealthy, and if that diet was persisted in, perished from inanition.[6] Dr. Stark made numerous experiments upon himself, to which, indeed, he ultimately fell a victim; from these it appears, that substances which afford most nutriment, if their use be persevered in for any length of time, to the exclusion of other diet, soon produce derangement of the stomach, and failure of its digestive power. Peculiarities are often met with in the stomachs of different individuals with respect to the power of digesting particular kinds of food. In this respect much depends upon previous habits; so that it is scarcely possible to establish any general rules with regard to the nutritious qualities of different species of aliment, that are not invalidated by innumerable exceptions. The quantity of liquid that is taken in along with the solid food is also exceedingly various in different individuals; that which is suited to the digestion of the one being found to disagree with another. If we except soups, which of course consist of the soluble parts of materials out of which they are prepared, and also milk, the liquids received into the stomach rarely contain any notable proportion of nutritious matter, but seem rather to aid the digestion of more solid food, either by supplying the place of a solvent, or by acting as a stimulus to the stomach. They are also in many cases necessary for supplying the loss occasioned by perspiration, which in hot climates, by regulating the temperature of the body, is essential to the preservation of health. These purposes are answered by many vegetable infusions, such as tea and coffee, and also by fermented liquors, although the latter contain to a certain extent many of the materials of nutrition, such as sugar and mucilage, besides the stimulant principle of alcohol.

3. *Condiments.*

Condiments.

(320.) With a view to the same stimulant effect, various substances are added in small quantities to our food, which act as condiments. Of these the principal is common salt, a taste for which seems to be natural to a great number of animals, and which, used in small quantity, has the effect of promoting digestion. Other condiments, such as pepper, mustard, garlic, and various other spices and aromatics, are employed chiefly from the agreeable impression they make upon the palate; but they in many cases check the tendency to fermentation which many kinds of food are liable to undergo in the stomach. As a general rule, to which, of course, there are many exceptions, whatever is agreeable to the palate is adapted also to the digestive powers of the stomach. A certain degree of variety in the articles of diet is more conducive to the nourishment of the body than confinement to any single article.

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[1] *Elementa Physiologiæ*, xix. 3, 2.

[2] *Physiology*, § 211.

[3] *Elémens de Physiologie*, § 3, p. 82.

[4] *Treatise on Digestion*, p. 84.

[5] For the year 1827, p. 355.

[6] *Physiologie*, tom. ii. p. 390.

Sect. IV.—*Appetites.*

1. *Hunger.*

Hunger.

(321.) Hunger is a peculiar sensation excited in the stomach by the want of food, and by the presence of the gastric juice in that organ conjointly. It is evidently an affection of the nerves of the stomach, for it is a good deal dependent on the state of the nervous system. Its periodical recurrence at stated times shews that it is a good deal under the dominion of habit. Hunger often suddenly ceases upon the occurrence of sudden emotions of grief or anger, and is much influenced by other causes of mental excitation. Literary men deeply absorbed in meditation often forget that they have occasion for nutriment, and are unconscious of the calls of hunger. Hence such persons are often great sufferers from disordered digestion.

(322.) The presence of the gastric juice appears however to be a natural stimulus to appetite, its primary action being probably in the nerves of the stomach. A similar effect may be produced, when the stomach is full, by taking spirituous liquors, or high-seasoned dishes. Those physiologists who were inclined to refer the phenomena of the living body to mechanical causes, ascribed the sensation of hunger to the friction of the surfaces of the stomach against one another, which they supposed took place when it was empty; but the anatomy of that organ, which, from its rounded form, and from the softness of its texture, would seem totally incapable of producing friction by any of its movements, is totally at variance with this hypothesis. Others have conceived that the collapse of the stomach in its empty state, by deranging the position of the liver and spleen, drags down the diaphragm, and thus excites irritation in the nerves of those regions; and they endeavour to support this doctrine by the alleged fact, that hunger is prevented and appeased by wearing a tight girdle, which occasions pressure on the stomach and gives support to the neighbouring organs. But the instances already given of the dependence of hunger on the states of the nervous system, are sufficient to prove that it is not owing to any mechanical cause.

(323.) The chemical physiologists attempted to explain the phenomena solely by the action of the gastric juice on the coats of the stomach, which they imagined it tended to corrode, and hence gave rise to an uneasy sensation. It is much more probable, however, that the impression made by this secretion is exclusively on the nerves of the stomach; and there is no doubt but that this action is one of the principal causes of hunger; for it has been found, that, if after long fasting, when there is a considerable accumulation of gastric juice, and when the sensation of hunger is extremely intense, it at once ceases if the gastric juice be removed by an emetic; or even if it be much diluted by taking large quantities of hot water.

(324.) The effects of long abstinence from food are, great loss of strength, emaciation, discoloration of the blood and of the secretions, an increase of nervous susceptibility, fever, loss of sleep, painful sensations in the region of the stomach, followed by total loss of appetite, delirium, and death. It has been said, that the exterior of the bodies of those who die of famine has exhibited a shining appearance in the dark, as if they had been impregnated with uncombined phosphorus.

2. *Thirst.*

Thirst.

(325.) Thirst is a sensation somewhat analogous to hunger with respect to its cause and effect, and with respect of its depending on particular states of the nervous system. It is considerably more distressing and intolerable than hunger. The seat of the sensation appears to be in the mouth and fauces, although its origin is generally in the state of the stomach, or general condition of the system. In the healthy condition of the organs it is a natural impulse prompting us to supply the system with the fluids requisite for carrying on its functions. But in the case of fevers, and other morbid states, thirst is sometimes excessive, and, if indulged without restriction, would prove highly injurious. In cases where a preternatural opening has been made into the œsophagus through the neck, the sensation of thirst is found not to be in any degree assuaged by fluids applied to the mouth, or even swallowed, if they escape through the wound, and do not descend into the stomach; whereas, it is immediately relieved when the same fluids are introduced into the stomach.

Sect. V.—*Preparation of the Food for Digestion.*

Prepara tory pr cesses.

(326.) The preparatory processes to which the food is subjected previous to its introduction into the stomach, are partly of a mechanical and partly of a chemical nature. It is masticated by the teeth and jaws, and at the same time mixed with the saliva and mucous secretions of the membrane lining the mouth, fauces, and œsophagus. The effect produced by these operations is to reduce the food to a soft and uniform pulp, which is more easily acted upon by the solvent powers of the gastric juice than if it had been swallowed entire.

1. *Mastication.*

Mastic tion.

(327.) During mastication a great number of muscles are called into action. The principal of these are the powerful muscles that elevate the lower jaw, namely, the temporal, the masseter, and the pterygoid muscles, the latter of which are capable of giving at the same time some degree of lateral motion to the jaw, adapting it thereby to effect a grinding action by the medium of the teeth. The lower jaw forms a lever of the third kind with a double angle, the fulcrum being at the condyles, which are curiously articulated with the skull, by means of an interposed cartilage. Its motions are almost entirely confined to those of elevation and depression; but it has also a more limited extent of lateral motion.

Teeth

(328.) The teeth, which are the great agents in mastication, have already been described and their different classes enumerated, under the head of ANATOMY. The respective purposes served by each class are sufficiently evident from their shape and position in the jaw. The incisor, or front teeth, are employed for cutting or dividing the food like a pair of shears or scissors; the cuspidati, or eye-teeth, placed a little farther back in the jaw, are particularly adapted to lay hold of, and tear asunder, fibrous textures that afford considerable resistance; their action may be compared to that of pincers. Mr. Hunter, after reviewing their different forms in the different tribes of quadrupeds, is enabled to trace a similarity in shape, situation, and use of the cuspidati, from the most imperfect carnivorous animal, which he believes to be the human species, to the most perfect carnivorous animal, the lion. The bicuspidati and molares compose what are called the grinding teeth, and their chief office is the trituration of substances already torn off by the cuspidati, or cut by the meeting of the incisors. The molares especially, being placed nearer to the articulation of the jaw, or centre of motion, act with greater power in exerting pressure on whatever is between them. If we wish to break a very hard body, the shell of a nut for example, we instinctively place it between the backmost molares, where the resistance it opposes to fracture acts by the shortest lever.

The bony substance of the teeth is preserved from the injury to which it would be exposed by the friction of hard substances, and by the contact of corroding fluids, and the influence of the air, by being cased in enamel, which, as we have seen, is considerably harder than bone. In consequence of the peculiar mode of its formation, the enamel is incapable of being renewed by a fresh growth when it has been worn away by friction. When, however, the teeth are lost by age, accident, or disease, their alveoli close and are obliterated by absorption; the gums then acquire a degree of hardness, that renders them an imperfect substitute for the teeth in mastication.

ongue.

(329.) The chief agent in distributing the food so as to place it in proper situations between the teeth for the purpose of mastication, and for transferring it to the fauces, is the tongue. This organ consists almost entirely of muscular fibres, which are variously arranged, and interwoven together in a very intricate manner, so as to render it capable of motion in every possible direction. Its root is affixed to a bone which is peculiar to it, called the *os hyoides*, from its resemblance to the Greek letter υ, which furnishes a basis of attachment to the greater number of the muscles of the tongue, and the extremities of which being extended considerably backwards, serve to keep the palate expanded and always prepared to receive the food. But the tongue also contains a set of muscular fibres, which proceed longitudinally through the centre of that organ, unattached to any bone, and serving to contract its length. The tongue is thrust out of the mouth, not by any power of elongation in the muscles, as might at first sight appear to be the case, but by the contraction of that portion of the radiating fibres proceeding backwards from the inside of the jaw and the os hyoides, and drawing forwards the root of the tongue when they act alone. This complex structure is admirably adapted to the great variety of uses to which the tongue is applied, not only in mastication and deglutition, but also in speaking.

(330.) The muscular actions of the lips and cheeks are also intimately concerned in mastication; and ample provision is made for their varied movements by being furnished with so great a number of muscles as those which cover the face, and are attached more or less to the lips and corners of the mouth.

2. *Insalivation.*

(331.) While the food is under the action of the organs of mastication which effect its mechanical division, it is at the same time mixed up with the saliva. This fluid is found, when chemically examined, to consist principally of mucus and albuminous matter held in solution in water, together with a small proportion of saline ingredients.

iva.

(332.) Dr. Bostock considered that he had detected two kinds of animal matter in the saliva, one composing the soft masses, and giving it its consistence and physical characters, nearly similar to coagulated albumen, the other dissolved in the water of the fluid along with the salts, and resembling the serosity of the blood.[1] Berzelius regards the former of these substances as corresponding in its properties to mucus, and states the saline ingredients to be chiefly alkaline muriates, with a small quantity of lactate of soda and of pure soda.[2] Tiedemann and Gmelin state the solid contents of the saliva to vary from one to twenty-five per cent, and to consist of salts, mucus, and ozmazome, to which are added, in some cases, a little albumen and a little fatty matter, containing phosphorus. The soluble salts consist of alkaline carbonate, which gives an alkaline character to the fluid, acetate, phosphate, sulphate, muriate, and sulpho-cyanate. The alkali in man is almost solely potass; while, in the dog and sheep, it consists of soda, with very little potass. The presence of sulpho-cyanic acid, on the other hand, is almost peculiar to the human saliva, being scarcely perceptible in that of the dog. Some insoluble salts, namely, phosphate of lime, carbonate of lime, and carbonate of magnesia, are also detected in the saliva, but in very minute quantity.[3] Leurat and Lassaigne, whose investigations were nearly contemporaneous with those of Tiedemann and Gmelin, represent the chemical properties of the chyle as being essentially the same in all animals, and consider the animal matter it contains as a species of mucus.[4]

(333.) When viewed by a good microscope, the saliva is generally found to contain globules of very minute size.

(334.) The saliva is secreted by the parotid and other glands in the vicinity of the mouth, and is poured out in considerable quantities during mastication. It has been estimated that about six or eight ounces of saliva are at each principal daily meal mixed up and incorporated with the food. It flows much more abundantly during a meal, and particularly if the food that is eaten possesses stimulating qualities, and has a sapid flavour. The quantity is augmented by the appearance, or even the idea of food, when the appetite is keen. The influence of the nerves which supply the salivary glands is very marked in regulating their secretions, as we shall have occasion to observe more at length, when we come to consider the function of secretion. The pressure of the muscles of the cheek on the parotid gland assists no doubt in the quick discharge of the secretion of that gland by its excretory ducts; and the same remark applies also to the submaxillary and sublingual glands, which also prepare saliva, and whose ducts open into the mouth; for we find, that during mastication all the muscles about the mouth are in continual action. The tongue presses the food on all sides, and thrusts it between the grinding teeth, while the muscles of the cheek, but more particularly the buccinator, against which the food is pressed by the tongue, forces it back again under the teeth, until the whole has been sufficiently subjected to their action; and during the whole of this time it is gradually receiving additions of saliva, which thus become intimately and uniformly mixed up with every portion of the divided food. When completely chewed, it is collected together on the surface of the tongue, which sweeps round the different parts of the mouth for this purpose, and moulds it into the form of a bolus; and the point of the tongue being then raised, and its basis depressed, an inclined plane is formed, along which the bolus is propelled backwards, and delivered to the pharynx, which is expanded to receive it.

3. *Deglutition.*

(335.) The action of swallowing, simple as it may appear to be, is in reality extremely complex, consisting of a succession of muscular contractions, nicely adjusted and balanced, so as to co-operate harmoniously in the production of one general effect, the descent of the food along the œsophagus. The whole exhibits one of the most beautiful examples of mechanical contrivance that is to be met with in the body.

Deglutition.

(336.) The pharynx, as we have seen, is a large muscular bag, shaped like a funnel, capable of being contracted in diameter, and of compressing its soft contents by means of the muscles which are expanded round it, and are called the constrictors of the pharynx. Other muscles are provided for elevating it, that is, for bringing it nearer to the base of the tongue. While the food is passing downwards, the velum pendulum is expanded, thrown backwards, and raised by the muscles adapted to perform these motions, so that it closes the posterior nostrils, and acting as a valve, prevents any portion of what is swallowed from passing either into those cavities or into the eustachian tubes. The bolus is thus directed towards the œsophagus, being carried thither by the peristaltic motion of the pharynx, while the root of the tongue being at the same time depressed, the epiglottis is turned backwards, and being applied to the glottis, accurately closes its aperture, so that no part of the alimentary matter can pass into the larynx. The mass of food being now arrived at the upper part of the œsophagus, is propelled towards the stomach by the successive contractions of its circular fibres. The mucus, which is secreted in abundance by all the surfaces along which it passes, and continually lubricates them, very much facilitates its descent. The longitudinal fibres of the muscular coat of the œsophagus contribute their share in this action, by shortening and dilating those portions of the canal into which the food is about to enter. Dumas distinguishes four stages in this process; first, that by which the aliment is propelled towards the pharynx; the second, consisting in the dilatation of that cavity, by which it receives the bolus transmitted to it; the third, by which the pharynx closes upon its contents, and propels it downwards to the œsophagus; and the fourth, in which, by the action of the œsophagus, the food is propelled into the stomach.[1]

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[1] *Edin. Med. Journal*, ii. 44.

[2] *Medioo-Chirurgical Transactions*, iii. 242.

[3] *Recherches sur la Digestion, par Jourdan*, p. 23.

[4] *Recherches Physiologiques et Chimiques sur la Digestion*, p. 33. See *Bostock's Elementary System of Physiology*, p. 487, note.

(337.) When any impediment exists to the due performance of these actions, fluids are swallowed with greater difficulty than solids, because the particles of the former having a continual tendency to spread themselves, it requires a closer and more exact application of the organs to prevent their escape, while they are compressed in giving to the fluid its proper direction. The action of suction performed by the tongue, with the assistance of the muscles of the cheeks and lips, which remove the pressure of the atmosphere from the surface of the fluid to which the mouth is applied, is also very complex. The tongue acts here as a piston; and sometimes the action is effected by the muscles of inspiration.

Sect. VI.—*Digestion or Chymification.*

Digestion. Office of the stomach.

(338.) The food has now passed from the œsophagus into the stomach, through its cardiac orifice, which has so been named from its supposed sympathy with the heart, near which it is situated. The office of the stomach is to convert the food which it receives into the soft pultaceous mass of a grey colour, which has been denominated *chyme*.[2] These secretions do not proceed from any glands that admit of being readily distinguished, their existence being rather inferred from the presence of the secretion. The membranes composing the coats of the stomach are capable of great distension, so as to contain a large quantity of food, while at other times that organ is contracted to a very small size, partly by the elasticity of its texture, but principally by the action of the circular and longitudinal fibres which encompass its cavity, and which constitute its muscular coat. These fibres are so disposed as to enable the different portions of the stomach to act separately and successively on its contents, producing what has been termed the *peristaltic*, or *vermicular motion*. Two purposes are answered by these actions; in the first place, the food contained in the stomach is agitated and thoroughly mixed together, while it is at the same time exposed to the chemical action of the gastric juice; and secondly, the ultimate effect of this motion is to carry the mass very gradually towards the pylorus, through which it is transmitted into the beginning of the intestinal canal.

(339.) While the food is thus rolled and agitated by the peristaltic action of the muscles, it is at the same time subjected to a degree of pressure, the purpose of which seems to be, to bring into closer approximation the solvent fluids with the materials on which they are to act, and thereby increase the chemical power of the former, and also to repress the evolution of gas, which has a tendency to be generated during the species of fermentation which the aliment undergoes in the process of digestion.

Gastric juice.

(340.) The principal agent in effecting those changes which constitute digestion, that is, which convert the aliment into chyme, is the gastric juice. The important office which this secretion performs has induced chemists to bestow great pains in obtaining its correct analysis, and in examining all its physical properties. When carefully collected, it appears to be a transparent and colourless fluid, having a saline and somewhat bitter taste, occasionally possessing acid properties, but probably in its natural and healthy condition being neither acid nor alkaline. It contains a small proportion of albumen, together with a matter which is either gelatin or mucus. But while it thus differs to all appearance in so trifling a degree from many of the other secretions, it yet possesses very extraordinary solvent powers over the substances usually employed as food. Even when made to act upon these substances in vessels out of the body, provided they are kept in a temperature equal to that of the human body, it will reduce them in a few hours to the state of a soft pulp, producing apparently the very same change which is induced upon the same species of aliment by the digestive process within the stomach. It is evident that the chemical analysis of the gastric juice affords as yet no clue to the explanation of this singular property. The power which the gastric juice possesses of coagulating milk, and other albuminous fluids, and of retarding the putrefaction of animal and vegetable substances subjected to its action, and even of counteracting this process when it has already commenced, are equally involved in mystery, and baffle all our endeavours to explain them on any of the hitherto known chemical principles.

(341.) There are three ways in which the gastric juice has been observed to act on alimentary matter; the first is that of coagulation, which is exerted on all the fluid forms of albumen, whether existing in the serum of the blood, or the white of the egg, or in different secretions, more especially milk. It is by means of this property, indeed, that cheese is obtained from the coagulation of its albuminous portion by the addition of rennet, which is an infusion of the digestive stomach of a calf. The object of this coagulation appears to be to detain the substance for a longer time in the stomach, and subject it more completely to the solvent power of the same fluid, by previously acquiring a solid form, which prevents its escape by the pylorus.

(342.) The second kind of action exerted on the food by the gastric juice is that of counteracting the tendency to putrefaction, and even to the ascescent fermentation. This effect takes place in a remarkable degree in many carnivorous animals, who frequently take their food in a half putrid state; and in whom the first operation of the gastric juice is to remove from it all putrescence; shewing that this secretion possesses the property not only of preventing putrefaction from taking place, but also of suspending its further progress when it has actually commenced.

(343.) The third species of chemical action exhibited by the gastric juice is that of solution. That this effect takes place independently of any concurrent mechanical operation of the muscular powers of the stomach has been very decisively proved by the experiments of Reaumur, of Stevens, and of Spallanzani. Those of Stevens in particular, are highly valuable, from being made on the human subject. He was fortunate enough to meet with a man who had been in the habit of swallowing stones, which he could afterwards, by a voluntary effort, reject by vomiting from his stomach. Taking advantage of this power, Stevens induced him to swallow hollow metallic spheres perforated with holes, and filled with different kinds of alimentary substances, which, after being allowed to remain a sufficient time in the stomach, were returned, and their contents examined. It was invariably found that the food under these circumstances of exposure to the gastric fluid alone, and protection from external pressure of a mechanical nature, was more or less completely dissolved, and reduced to the state of a pulp. He afterwards pursued a similar train of experiments on dogs, causing them to swallow the perforated spheres, and after a certain time destroying the animals, and examining the changes effected in their contents.

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[1] *Physiologie*, tome i. p. 341.

[2] The older authors made no distinction between *chyme* and *chyle*, the latter substance being the product of the formation of the small intestines.

(344.) Spallanzani has also varied and multiplied experiments of this kind in a manner that leaves no room to doubt the truth of the conclusion deduced from them as to the solvent power of the gastric secretion. Dense membranes and even bones are reduced into a pulpy mass by this fluid in many animals, while at the same time many bodies of comparatively delicate textures, such as the skins of fruits, and the fibres of flax or cotton, are not in the slightest degree affected by it. This difference of action on different substances is analogous to the operation of chemical affinity, and corroborates the theory that digestion is effected principally by chemical agency. The results of these experiments have been fully confirmed by experiments made on the stomachs of persons, who, in consequence of a wound, had a permanent opening into that organ from the skin of the abdomen.

(345.) Portions of the stomach are sometimes found dissolved after death. This takes place more especially when death has occurred suddenly during the act of digestion. This effect can never take place during life, because the living structures resist the solvent power of the gastric juice, which affects only dead animal matter. Thus it happens that worms, and the larvæ of insects live for a considerable time in the stomach, without being acted upon by its secretions.

Evolution of gas.

(346.) Gas is frequently evolved in the stomach during the process of digestion; but this would appear to take place only in a disturbed or morbid condition of that process, and by no means to be a necessary attendant upon healthy digestion.

(347.) Acid is also frequently developed during imperfect digestion; but it appears from the experiments of Dr. Prout, which have been fully confirmed by other experimentalists, that this effect is also attendant upon healthy digestion, and that it is principally the muriatic acid which is thus disengaged from its combinations, and makes its appearance in a free state. The lactic acid, an acid which appears to be a modification of the acetic, also is present in considerable quantity.

Evolution of acid.

Professor Tiedemann and Gmelin, in an elaborate treatise on Digestion lately published, found the acetic acid always present in the gastric juice. They observe that water alone, at the temperature of the human body, is capable of dissolving many of the substances employed as food; and of these many that are not soluble in water are so in the diluted muriatic and acetic acids at a high temperature, and they are inclined to ascribe to a chemical solution of this kind the principal change effected by digestion.

(348.) Among the agents concerned in the digestion of the aliment, the high temperature at which the contents of the stomach and intestines is retained, must be considered as one of the most important. The heat of the body unquestionably tends to promote the chemical action of the secretions which effect these changes. While digestion is taking place, both orifices of the stomach are closed, and there often comes on a feeling of chilliness, especially in a weakly constitution, in consequence of the demand which the stomach makes upon it for an additional supply of heat to assist in the process that is going on. There is also disinclination to exertion, and frequently a tendency to sleep while digestion is performing. Yet the indulgence in this disposition, as well as violent exercise immediately after a meal, tend equally to retard the formation of chyme. The circumstances most favourable to perfect digestion, are gentle exercise, with cheerfulness, and moderate mental exertion.

(349.) It appears from Dr. W. Philip's experiments, which were conducted chiefly on rabbits, that food recently taken is always kept distinct and unmixed with that which has remained for some time in the stomach, the former being introduced into the centre of the mass previously present. The food is more digested the nearer it is to the surface of the stomach, and is least digested in the small curvature, more so at the larger end, and still more perfectly at the middle of the great curvature. The state of the food found in the cardiac portion is different from that found in the pyloric portion of the stomach; for in the latter it is more uniform in its consistence, more dry and compact, and apparently more thoroughly digested. Thus it would appear that it is at the large end of the stomach where the gastric juice is secreted in greatest abundance, that the first and principal operations of digestion take place, and that from this part the food is gradually propelled towards the small end, becoming more completely changed during its progress.

It appears from the experiments of De Beaumont on an individual who lived many years with a fistulous opening into the stomach, which allowed the contents of that organ to be at all times examined, that the different kinds of aliment all require to undergo the chemical action of the gastric juice in order to be reduced to the state of chyle; but that the rapidity of this process differs considerably, according to the delicacy of the natural texture of the food, and the extent of its previous mechanical division. Animal substances are found to be more rapidly converted into chyme than vegetable; and oily substances, although containing a large proportion of nutritious elements, are comparatively difficult of digestion. Some curious evidence was afforded by Dr. Roget and Dr. P. M. Latham, on the occasion of an epidemic scurvy which prevailed in the years 1823 and 1824, among the prisoners in the Milbank Penitentiary, that too liquid a diet, consisting of too large a proportion of soups, although abundantly supplied, did not furnish sufficient nourishment for the preservation of health; probably from their not being retained in contact with the coats of the stomach during the time requisite for their undergoing the process of digestion[1].

Theories of digestion

(350.) A great number of hypotheses were devised by the older physiologists in order to explain the process of digestion. These we shall only briefly enumerate, without engaging in any laboured refutation of what, in the present advanced state of science, does not require much examination to prove the fallacy. The ancients had generally adopted the opinion of Hippocrates, which was enforced by Galen, that the food was digested by what was called a process of *concoction*. This, however, seems to be only another term for digestion, instead of affording any explanation of its nature. Some physiologists considered digestion as resulting from a degree of putrefaction; a process which is in reality of a totally opposite nature, although agreeing in some minor points, such as the breaking down of the cohesion of the particles, and the occasional disengagement of gas. Others, reasoning from the analogy of the stomachs of granivorous birds, which are provided with a strong muscular apparatus for the purpose of grinding, conceived that a similar process took place in the human stomach, and that digestion was the effect of mechanical trituration. But the experiments of Stevens and Spallanzani, the results of which have been already stated, are alone sufficient to overturn this hypothesis.

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[1] See *An Account of the disease lately prevalent in the General Penitentiary*. By P. M. Latham, M.D. London, 1825.

(351.) The earlier chemical physiologists ascribed digestion to a species of fermentation. This term, however, appears to have been misapplied, in as far as digestion is conceived to be identical with either the acetous or vinous fermentations; and if it were meant to convey the idea of a peculiar species of chemical change taking place in the stomach, and in no other situation, then nothing is gained by the substitution of the term employed for that of digestion, which must express precisely the same idea. More modern writers have imagined they were giving an explanation of the phenomena of digestion, by referring them simply to the action of the vital principle, or the vital powers, or the principle of life, or by whatever name they chose to designate an imaginary agent which gave rise to all those phenomena, not referable either to mechanical or chemical principles. But after the remarks we have elsewhere made on this radical error of substituting final for physical causes, and of prematurely generalizing the principles which actuate the living system, it is needless farther to insist upon the fallacy of this mode of reasoning.

(352.) A doctrine has lately been advanced, with greater semblance of truth, that digestion is essentially a nervous function; that is, one which is directly dependent on nervous power. A variety of facts unquestionably prove that the functions of the stomach are very much influenced by the states of the nervous system. The section of the par vagum, or eighth pair of nerves, in the neck of an animal, is followed by the almost total interruption of digestion; whence we may infer that the influence conveyed by these nerves is necessary both for the secretion of the gastric juice, and perhaps also for the muscular actions of the stomach. It is exceedingly remarkable, however, that where the galvanic influence is sent through the mutilated nerves, by means of a voltaic battery, digestion may be renewed, and goes on for a considerable time; whence it has been inferred by Dr. W. Philip, that the nervous power, or the agency which is conveyed through the nerves, and which influences secretion, is itself identical with the electric or galvanic fluid.

Function of the pylorus.

(353.) The pyloric orifice of the stomach is furnished with a circular band of fibres, covered by a fold of the nervous coat; and acting as a sphincter muscle, which closes the passage during the early stages of digestion, so as not to suffer the escape of the food until it has undergone the requisite changes which constitute its digestion. The aliment is conveyed to the pylorus in proportion as it has undergone these changes. There appears to exist in this part of the stomach a peculiar and extremely delicate sensibility, and a power of selecting those portions of the food that are properly digested, and of allowing them to pass, while those which are undigested are retained in the stomach.

It would appear, however, from some recent experiments, that a portion of aliment passes unchanged through the pylorus along with the chyme. We observe, for instance, that many hard substances, such as the stones of cherries and plums, find their way through the pylorus without much difficulty. The seeds of many plants are only softened by their detention in the stomach, and passing with no other change through the intestinal canal, are prepared for germination in the soil to which they may be transferred. Thus many species of plants and trees have been known to grow at places very remote from each other in consequence of their seeds having been conveyed by birds that had swallowed them.

CHAP. VII.—CHYLIFICATION.

(354.) The aliment, now converted by the process of digestion into chyme, after passing the pylorus, enters into the duodenum, which is the first of the small intestines. In the duodenum the chyme undergoes further changes, which are quite as great and as essential to its proper assimilation, as those which the food experienced in the stomach, and they are at the same time involved in equal obscurity. Almost all that is known respecting the nature of these changes, is, that soon after the chyme has been received into the intestines, it begins to separate into two parts; the one a white milky fluid, which is termed the *chyle;* and the other, residual matter, which afterwards becomes *fæces*, and is eventually ejected from the body.

(355.) Previously to our examining the processes by which this separation is effected, it will be proper to consider the chemical properties of the chyle.

1. *Properties of Chyle.*

Properties of chyle.

(356.) Chyle is the fluid which is prepared from the food taken into the stomach, and which, being the last process of digestion, is formed in the intestinal canal. It is only of late years that we have acquired any accurate knowledge of its chemical properties. It is evident that experiments on this fluid can only be instituted on quadrupeds, and that it is only by reasoning from analogy that we can extend the knowledge so obtained to the human economy. If chyle be taken from the thoracic duct of an animal a few hours after it has taken food, it has very much the appearance of cream, being a thick fluid of an opaque white colour, without smell, and having a slightly acid taste, accompanied by a perceptible sweetness. It restores the blue colour of litmus, previously reddened by acetic acid; and appears, therefore, to contain a predominance of alkali. When subjected to microscopic examination, chyle is found to contain a multitude of globules, of smaller diameter than those of the blood, and corresponding in size and appearance to those of milk. In about ten minutes after it is removed from the thoracic duct, it coagulates into a stiff jelly, which in the course of twenty-four hours separates into two parts, producing a firm and contracted coagulum, surrounded by a transparent colourless fluid.

(357.) The coagulated portion, according to Vauquelin, is a substance of a nature intermediate between albumen and perfect fibrin, marking the transition from the one to the other. It has perhaps, indeed, a closer resemblance to the caseous part of milk than to fibrin. It is rapidly dissolved both by pure and sub-carbonated alkalies, forming pale brown compounds. Its solution in ammonia has a reddish hue. The acids throw down a substance intermediate between fat and albumen, which an excess of nitric acid redissolves in the cold; and sulphuric, muriatic, oxalic and acetic acids, by boiling for a short time, also dissolve it. Diluted sulphuric acid also very readily effects its solution. Very dilute nitric acid gradually converts it into adipocire; when the acid is more concentrated, the coagulum assumes the appearance of gelatin; and when heat is applied, oxalic and carbonic acids are evolved. It is insoluble either in alcohol or ether.

(358.) That portion of chyle which retains the liquid form contains a portion of albumen, which may be coagulated by heat, alcohol, or acids. The clear liquid, reduced by evaporation to half its bulk, deposits crystals, which were found by Mr. Brande to bear a strong resemblance to those of sugar or milk.

(359.) A few saline bodies, similar to those existing in most animal fluids, were found by Dr. Marcet, to be present in chyle.

(360.) The principal ingredients in chyle are, therefore, according to Vauquelin, 1st, a large proportion of albumen; 2d, a smaller one of fibrin; 3d, a fatty substance which gives to the chyle the appearance of milk; 4th, several salts, such as carbonate of potass, muriate of potass, and prophosphate of iron.

(361.) Berzelius is strongly inclined to distrust the supposed analogy between chyle and milk, as having but little foundation in their real chemical nature.

(362.) It would be exceedingly interesting to ascertain the differences which exist in the properties of chyle taken from different orders of animals, that we might be able to trace the influence of different kinds of food upon this fluid. Dr. Marcet and Dr. Prout have made comparative experiments with this view upon the chyle taken from different dogs, some of which were fed exclusively on animal, and others on vegetable food. The chyle in the former case was found to be much whiter, contained more solid matter, and yielded more albumen than in the latter. The general results of these experiments are contained in the following table. Some faint traces of oily matter and of sugar of milk were obtained, but in quantities too minute to be estimated.

	Chyle from vegetable food.	Chyle from animal food.
Water	93·6	89·2
Fibrin	·6	·8
Incipient albumen	4·6	4·7
Saline matters	·8	·7

(363.) When both kinds of chyle were submitted to destructive distillation, the vegetable chyle produced three times as much carbon as the animal chyle; the latter, therefore, probably contained a greater proportion of hydrogen and nitrogen. The chyle of a horse, derived of course from vegetable food alone, was found by Vauquelin to be in a more animalized state than that which Dr. Marcet procured from dogs. Dr. Prout, also, comparing the chyle as prepared from vegetable and from animal food, found the former to contain more water and less albuminous matter, while the fibrin and the salts were nearly the same in both, and both exhibited traces of oily matter. On the whole, he states the difference between the two kinds of chyle as being less considerable than had been observed by Dr. Marcet. On tracing the successive changes which the chyle undergoes in its passage along the vessels, he found that its resemblance to blood increases in each of these successive stages of its progress.[1]

2. *Functions of Intestines.*

Chylification.

(364.) At the part of the duodenum where the separation of the chyme into chyle and residual matter takes place, the ducts from the pancreas and the liver terminate, so that the chyme is subjected to the action of the secretions from these two important glands, namely, the *pancreatic juice*, and the *bile*, which slowly distil into the duodenum. Sir Benjamin Brodie concluded, from experiments which he made upon living animals, that the formation of chyle is the immediate result of the admixture of bile with the chyme. In studying the changes which occur in this process, it will be necessary first to examine the chemical properties of these secretions.

Pancreatic juice.

(365.) The secretion from the pancreas, which flows into the intestine, and is mixed with the digested food almost immediately on its exit from the stomach, has, no doubt, some share in the process of chylification; but as it appears to be exceedingly analogous, both in its sensible properties and chemical composition, to the saliva, it is difficult to understand the mode of its operation, independently of mere dilution. As it is found, however, to contain a large quantity of albumen, a great portion of this substance may perhaps go to the formation of chyle.

3. *Properties of Bile.*

Bile.

(366.) The bile, a secretion prepared by the liver, is poured into the same part of the intestine as the pancreatic juice. Its great importance in the animal economy induced physiologists from the earliest times to pay much attention to its chemical properties. Its analysis has been attempted by Boyle, Boerhaave, and Baglivi, and more recently by Fourcroy, Cadet, Thenard, and Berzelius. But it unfortunately happens, that in several important particulars the accounts given by these different chemists do not accord with one another. These discrepancies, as Mr. Brande observes, seem partly to arise from the extreme facility with which chemical reagents react on this secretion, so that many of the supposed *educts*, or component parts which have been enumerated by different chemists, are probably *products* of the different operations to which it has been submitted, or, at all events, modifications of its true proximate elements.[2] The bile of the ox, from the facility of preserving it, has been that chiefly selected as the subject of experiment, and made the standard of comparison with that of man and other animals.

(367.) The substances to which this fluid owes its specific properties are, according to Thenard, first, a peculiar inflammable resin, soluble in alcohol; secondly, *picromel*, a substance insoluble in water and in alcohol, incapable of being crystallized, but forming, with resin and a small portion of soda, a triple compound which is soluble in water; and it is in this state that it exists in bile; and, thirdly, a yellow matter, distinct from either of the former. In addition to the soda, which is combined with the resin and picromel, bile contains a small quantity of phosphate, muriate and sulphate of soda, as also phosphate of lime, and a minute trace of iron.

(368.) Berzelius denies the correctness of the distinctions which Thenard has endeavoured to draw between the three animal ingredients of bile above mentioned. He gives to its characteristic principle, the name of *biliary matter;* and describes it as being of a resinous nature, and precipitable by acids; the precipitate, or *picromel*, or the *gallensteff* of Berzelius, being a compound of the acid employed and this biliary matter. According to Thenard, human bile differs from that of the ox chiefly in containing no picromel. M. Raspail considers bile to be essentially a saponaceous substance, with a trace of soda.

(369.) The peculiar matter of *bile* is found in the residual matter, and does not enter into the composition of chyle. The chief uses of the bile appear to be those of a chemical agent, promoting the decomposition of the chyme, and also stimulating the secretion of mucus, and the peristaltic motion of the intestines. Digestion may, however, go on to a certain degree, and imperfectly, although the flow of bile into the intestines be entirely prevented.

4. *Functions of the Small Intestines.*

(370.) Professors Tiedemann and Gmelin found, from their experiments, that the upper part of the small intestines contains a considerable quantity of uncombined acid, which is principally the acetic, mixed with a little butyric, and rarely with the muriatic On proceeding to the lower parts of the small intestines, they found the fluids had alkaline instead of acid properties. This gradual disappearance of acid is probably in part the effect of its neutralization by the free alkali contained in the bile. The following, according to these physiologists, are the changes which take place in the contents of the small intestines. The chyme, which is acid, mixes with the bile, the pancreatic juice, and the mucous secretion from the coats of the intestine. The muriatic acid combines with the soda of the bile, and at the same time disengages from it the acetic or carbonic acids with which it had been previously united. It also separates the mucus and cholesterine of the bile in the form of white flakes, which have often been mistaken for chyle. The pancreatic juice and the intestinal mucus contribute, in some unknown manner, to this effect. Their chemical changes are promoted, and the contents of the intestines successively propelled forwards along the whole tract of the canal, by the peristaltic actions of the muscular coat, the effects of which are analogous to those we have already described as taking place from a similar action in the stomach.

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[1] *Annals of Philosophy*, xiii. 22.

[2] *Cyclopædia of Anat. and Phys.* art. Bile.

5. *Function of the Spleen.*

Function of the spleen.

(371.) It is probable that the spleen is an organ subservient to some purpose connected with digestion; but what that precise purpose can be is a question involved in great obscurity. A vast number of hypotheses and conjectures have been hazarded on this subject; but they are, for the most part, devoid of even the slightest probability. Any theory that assigns a very important office to the spleen will be overturned by the fact, that in many animals the removal of this organ, far from being fatal, or interrupting in any sensible manner the continuance of the functions, seems to be borne with perfect impunity. Sir E. Home has of late years advanced an opinion, for which there appears to be some probability, namely, that the spleen serves as a receptacle for any superfluous quantity of fluid taken into the stomach, and which, if not removed, might interfere with the regular process of digestion. This excess he supposes is transmitted directly to the spleen by communicating vessels, and lodged there until it is gradually removed, partly by the veins, and partly by the absorbents.

(372.) It appears, indeed, from the observations of Bichat, Leuret, Lassaigne, and others, that during digestion, and even after copious draughts of liquids, the vessels of the spleen become exceedingly turgid with blood. Hence the opinion has arisen, that the chief use of the spleen is to relieve the stomach and intestines from that congestion which would otherwise take place in their blood-vessels during digestion. The very vascular, approaching to a cellular structure, of the spleen, which very readily admits of dilatation, would seem to countenance this hypothesis.

6. *Functions of the Large Intestines.*

Functions of the large intestines.

(373.) The functions of the large intestines are not confined to the mere conveyance and expulsion of feculent matter, although the exact nature of the changes which take place in their contents, and the subserviency of those changes to the object of nutrition, have never been clearly determined. It would appear that some important changes are effected in that enlarged portion of the canal which is termed the *cæcum*, and which has by some been regarded as a kind of supplementary stomach, in which fresh chyme is formed, and fresh nutriment extracted from the materials that have passed through the small intestines. This chymous product is supposed to be converted, as in the former case, into a species of chyle, which, from containing a greater proportion of oil, bears a resemblance to fat, and is in this state absorbed from the inner surface of the great intestines. The capability of the great intestines to extract nourishment from their contents is proved by the fact, that nutritious matter injected into them has been known to support life for a certain time, and also from their being able to effect the coagulation of milk.

(374.) A certain quantity of gas is almost constantly present in the intestinal canal, and often also in the stomach. Magendie and Chevreul, who have analysed these gases, found that what the stomach contained consisted of a mixture of oxygen and nitrogen; but that in the lower intestines the oxygen had wholly disappeared, as also a great part of the nitrogen, and that, instead of these, the component parts of the gas were carbonic acid, hydrogen, carburetted hydrogen, and a little sulphuretted hydrogen.

(375.) The time required for the completion of the processes we have described as taking place in the stomach, the small, and the large intestines, varies much, not only according to the nature of the food, but according to the conditions of the organs and of the general health, and to constitutional peculiarities. The digestion of food in the stomach is usually considered as requiring three or four hours. Animal food is longest retained, and undergoes the greatest alteration in the stomach. Vegetable food, on the other hand, passes more quickly and with less alteration, out of the stomach, and undergoes more change in the intestines than animal food.

SECT. VIII.—*Lacteal Absorption.*

Lacteal system.

(376.) The chyle, which has been prepared in the duodenum, and along the whole course of the small intestines, in the manner we have described, is received by absorption into the lacteals, and by them conveyed to the thoracic duct, which transmits it to the great veins in the vicinity of the heart. The lacteal vessels may be considered as forming part of the great system of absorbents which, as we shall afterwards find, are extensively distributed throughout the body. We shall therefore reserve their description until a general account is given of this system, in treating of the function of absorption generally.

(377.) The discovery of the lacteals was made in the year 1622 by Aselli, in the mesentery of a dog, which he had killed a few hours after the animal had made a plentiful meal. Their termination in the thoracic duct was discovered by Pecquet in 1651. They originate by open mouths from the villi of the inner coat of the small intestines, in the form of very minute tubes, which soon unite into one common vessel proceeding from each of the villi; and these vessels afterwards joining successively form larger and larger branches, which ascend along the mesentery, generally following the course of the veins, till they are collected at the root of the mesentery, and, after passing through numerous glands, terminate at the lower end of the thoracic duct, where there is an enlargement which has been called the *receptaculum chyli*.

(378.) Since uncertainty, however, still exists respecting the minute anatomy of the lacteals, at their origin from the intestine, many anatomists having in vain sought for the appearances above described. Their open orifices can only be seen when the lacteals are distended with chyle, and they are more readily detected in fishes where they have no valves, and where therefore the branches admit of being injected from their trunks. Their coats, although thin and perfectly transparent, yet possess considerable strength, so as to allow of being distended by injections without being ruptured; and even afford decisive indications of having the power of contracting and propelling forwards their contents. The utility of the numerous valves with which they are provided in every part of their course, in preventing any retrograde motion of the fluid they transmit, is sufficiently obvious.

(379.) The power by which the chyle is made to enter the open orifices of the lacteals, is by no means easily determined. It has been referred generally to capillary attraction. But the application of the laws which govern the ascent of fluids in rigid inorganic tubes, to the elastic vessels of the living system, is liable to much fallacy. The phenomena appear to indicate that the lacteals exercise, in the exclusive absorption of chyle, a power of selection somewhat analogous to that of chemical or electric attraction. It has been supposed, accordingly, that there is a specific attraction between chyle and the lacteal vessels, which causes that fluid to enter into them; while other fluids which are presented to the same vessels are rejected. This obscure subject has given rise to various speculations, which are more curious and ingenious than leading to any satisfactory conclusion. It is now generally agreed among physiologists, that the power which the lacteals possess of admitting the absorption of extraneous substances, if it exist at all, is exceedingly limited, and is exerted only on rare occasions.

Various experiments made on animals fully warrant the conclusion, that by far the greater portion of the nutritive matter imparted to the system is conveyed into the blood-vessels through the channels we have been describing, namely, the lacteals and the thoracic duct. On the other hand, there appears to be evidence that a large portion of the thinner fluids received into the stomach passes at once into the veins by the immediate absorption of these veins: for they always disappear rapidly from the stomach, in whatever quantity they are introduced. It is probable also, that some admixture of the contents of the lacteals with those of the blood-vessels takes place in the mesenteric glands, and that part of the chyle finds its way into the mesenteric veins by more direct channels than that of the general circulation.

(380.) An elaborate series of experiments was undertaken by Tiedemann and Gmelin, with a view to ascertain whether there exists any direct communication between the digestive cavities and the blood-vessels, exclusive of the known channel through the lacteals and thoracic duct. The experiments consisted in mixing with the food of certain animals various odorous, colouring, and saline materials, the presence of which might be easily detected by their appearance, odour, and other sensible or chemical properties; and in comparing, after a proper interval of time, the state of the chyle with that of the blood in the mesenteric veins. The odorous substances employed were camphor, musk, alcohol, oil of turpentine, and assafœtida. These were generally discovered to have found their way into the system, by their being detected in venous blood, in the urine, but not in the chyle. The colouring matters were sap-green, gamboge, madder, rhubarb, alkanet, and litmus; these appeared, for the most part, to be carried off without being absorbed; while the salts, namely potass, sulphuro-prussiate of potass, muriate of barytes, muriate and sulphate of soda, acetate of lead and of mercury, and prussiate of mercury, were less uniform in their course. A considerable portion of them seemed to be rejected, while many of them were found in the urine, several in the venous blood, and a very few only in the chyle. Hence the authors conclude, that the odorous and colouring substances never pass into the lacteals, and that saline bodies do so occasionally only, or perhaps incidentally; the whole of them are, however, found in the secretions, and they must, therefore, have entered into the circulation by some other channel than the lacteals.[1]

(381.) There appears not, as far as we know, to be any thing specific in the action of the thoracic duct, which, as it appears, transmits its contents into the subclavian vein, as it receives it from the absorbents.

SECT. IX.—*Sanguification.*

guifica-

(382.) The chyle consists, as we have seen, of alimentary matter, reduced to a certain state, which may be regarded as the first stage of animalization, having already made a near approach to the nature of that blood into which it is afterwards to be converted. This conversion of chyle into blood takes place after its introduction into the sanguiferous system of vessels, and while it passes round in the course of circulation. During this course, it necessarily traverses the minute vessels of the lungs, where it is subjected to the chemical action of atmospheric air, and its constituents gradually acquire the characteristic properties which they possess as the ingredients of the blood. The chief changes experienced are, first, that the fibrin of the chyle obtains a greater cohesive tendency, and a power of spontaneous coagulation; and, secondly, that the white globules of the chyle receive an addition of red colouring matter, and are invested with an external vesicle, by which their size is increased. But in order correctly to estimate their changes, it will be necessary to take a general review of the chemical and other physical properties of the blood.

Properties of blood.

(383.) The nature and properties of the blood have attracted a very large share of the attention of physiologists in all ages; and immense labour has been devoted to the investigation of its chemical constitution.

(384.) When examined immediately on its being drawn from the vessels, the blood appears as a smooth and homogeneous fluid, of an unctuous adhesive consistence, of a slightly saline taste, and of a specific gravity somewhat exceeding that of water. It exhales a vapour which has a peculiar smell; but which, when condensed and collected, affords a liquor not differing sensibly from water. Much importance was formerly ascribed to this vapour, which was dignified with the name of *Halitus*. As the blood does not preserve the same consistence at different times, its density is liable to variation. Haller states the specific gravity of human blood to be at a medium, 1.0527. Dr. Milne Edwards says that it varies from 1.052 to 1.057. Dr. Davy states that the specific gravity of arterial blood is 1.049, and of venous blood, 1.051. Although it appears homogeneous, it is found by microscopical examination to contain a large proportion of minute globular particles, diffused through a liquid.

Halitus.

Coagulation.

(385.) In a few minutes after its removal from the body, a thin film appears on the surface, and after a short time, which on an average is about seven minutes, the whole mass becomes cohesive, and what is termed its *coagulation* has taken place. After it has remained for some time in this gelatinous state, a separation of the mass into two distinct parts gradually takes place. A yellowish liquid oozes out from beneath the surface of the mass, and at length the whole is resolved into a clot, or solid portion of a dark red colour, which is called the *crassamentum*, or *cruor*, and consists chiefly of fibrin, and a yellowish liquid, called the *serum*. The proportion between these two parts has been variously estimated; and does not indeed admit of accurate determination, from its being variable in itself under different circumstances. On an average, however, it may be stated, that the crassamentum amounts to about one-third of the weight of the serum. Dr. Scudamore and Mr. Wood found, however, by taking the mean of twelve experiments, that the crassamentum amounted to 53.307 per cent. The period at which coagulation begins and is completed, varies not only with the condition of the blood itself, but also with the circumstances in which it is placed. It commences sooner as the vessel is more shallow; but on an average it may be said to begin in about three or four minutes, and to be completed in seven or eight. But the contraction of the coagulum continues for a long time after, and sometimes does not cease till the fourth day. It does not appear that the specific gravity of the blood is sensibly altered during its coagulation.

Crassamentum and serum

Rise of temperature.

(386.) Great difference of opinion has existed as to the occurrence of a change of temperature during this process of coagulation. The analogy of other instances in which the conversion of a fluid into a solid is accompanied with the evolution of heat, has induced many to think that a similar effect attends the coagulation of the blood. Fourcroy stated, that a rise of temperature actually takes place; but Hunter, on the contrary, adduced facts leading to an opposite conclusion. The result obtained by Fourcroy has, however, been confirmed by the experiments of Dr. Gordon, who found that the coagulating portion of a quantity of blood was warmer than the rest by about six degrees. On repeating the experiment on blood drawn from a patient labouring under inflammatory fever, the rise of the thermometer was no less than twelve degrees. Subsequent researches by Dr. John Davy, have, however, thrown considerable doubt upon the accuracy of the above conclusion, by pointing out some sources of fallacy in the investigation of Dr. Gordon. Dr. Scudamore, on the other hand, found that heat was produced during coagulation, but to a less degree. Vogel and Brande have ascertained that carbonic acid gas is disengaged; and this appeared to happen to an unusual extent in blood drawn soon after a meal.

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[1] *Edin. Med. Journal*, xviii. p. 455, &c. The above analysis of these experiments is that given by Dr. Bostock in his work on Physiology, p. 617, note.

Conditions for coagulation.

(387.) The coagulation of the blood is a phenomenon not strictly analagous to any other with which we are acquainted, and has never been satisfactorily explained. The operation of external agents upon it is not so well marked as to enable us to refer it to any general operation of the physical properties of matter. Moderate differences of temperature produce scarcely any perceptible difference in the tendency which the blood has to coagulate. Within the range of from 67° to 105°, blood coagulates in the same time as at the usual temperature of 98°. Sir Humphry Davy found that no difference in this respect takes place when blood is exposed to nitrogen, nitrous, nitrous oxide, carbonic acid, carborated hydrogen gases, or atmospheric air, although the contrary had been asserted by Luzuriaga. Blood, indeed, coagulates more quickly when placed in a receiver from which the air is rapidly exhausted, when slowly drawn into a shallow vessel, or when exposed to atmospheric air, at a temperature of 120°. This process is retarded by a very low temperature. Mr. Hewson placed blood in oil at a temperature of 38°; at the expiration of six hours it continued fluid; but being then allowed to attain a warmer temperature, it became coagulated in twenty-five minutes. The same physiologist froze a portion of blood confined by ligatures in the jugular vein of a rabbit; when thawed, the blood became liquified, and coagulated. Admixture with certain neutral salts prevented altogether coagulation from taking place. This happened when half an ounce of sulphate of soda was mixed with six ounces of fresh blood; but on the addition of a double quantity of water coagulation took place. Dr. Turner states that the coagulation of the blood is prevented by the admixture of saturated solutions of chloride of sodium, hydrochlorate of ammonia, nitre, and potass; while, on the contrary, alum, and the sulphates of the oxides of zinc and copper, promote coagulation. Blood coagulates slowly when drawn quickly into a deep vessel, or when detained at rest in the vein of a living animal between two ligatures. In the latter case, Mr. Hewson found the blood two-thirds fluid after the lapse of three hours and a quarter. When the experiment was varied by blowing air into the vein, the blood was found to have coagulated in a quarter of an hour. Blood extravasated through the rupture of vessels, and retained in the cavities of the body, often preserves its fluidity for a very considerable time. If the causes which are capable of postponing coagulation have continued to operate beyond a certain period, the blood is prevented from coagulating; thus recent blood remains permanently fluid if it be constantly stirred for some minutes. It has been proved by the experiments of Hewson, Hunter, Deyeux, and Parmentier, that the coagulation of blood is not entirely prevented by diluting it with water; but Dr. Crawford[1] showed that this process is retarded for several hours by the admixture of blood with twelve times its bulk of water.

(388.) There are many conditions of the living system that have a prodigious influence on the tendency of the blood to coagulate, and that operate in a manner which it is impossible to explain. Many causes of sudden death, as a blow upon the stomach, or violent injury to the brain; lightning and electricity; several animal poisons, as that of venemous serpents; narcotic vegetable principles, as cyanogen; also excessive exercise, or even violent mental emotions, when they produce the sudden extinction of life, prevent the usual coagulation of the blood from taking place.

Vitality c blood.

(389.) The doctrine maintained by Hunter, that the blood possesses life, and that its coagulation is one of the acts of this living principle, is but little calculated to remove the difficulty; for the operation of this principle in producing coagulation would still be as much in need of explanation as the phenomenon itself, which it professes to account for. We must, in the present imperfect state of our knowledge, content ourselves with referring this phenomenon to an inherent disposition which the fibrin possesses to assume the solid form, when no counteracting cause is present. Dr. Bostock,[2] observes, that as it is gradually added to the blood particle by particle, while this fluid is in a state of agitation in the vessels, it has no opportunity of concreting; but when it is suffered to lie at rest, either within or without the vessels, it is then able to exercise its natural tendency.

(390.) We have already stated that the crassamentum consists chiefly of fibrin; but it owes its dark colour to the presence of what are called the red particles of the blood, and which are entangled in it during its coagulation. The serum, which is the part of the blood that remains fluid after the coagulation of the fibrin, is itself coagulated by heat, in consequence of the large proportion of albumen it contains; the remaining portion which still continues fluid, is termed the *serosity*. The following is therefore the arrangement of the principal proximate parts of the blood, in the order of analysis.

Analysis blood.

Coagulated blood consists of	Crassamentum	Fibrin
		Red particles.
	Serum	Albumen.
		Serosity.

Crassamentum.

(391.) The crassamentum is a mass of a soft consistence, which easily bears cutting with a knife. Its mean specific gravity is about 1·245. By long continued ablution in water, it may be freed from the red particles which it contains, and which are soluble in water. This may conveniently be effected by enclosing the crassamentum in a linen bag, immersing it repeatedly in water, and at the same time pressing it gently; or by allowing a stream of water to fall upon it, till the water runs off colourless. There remains a white, solid, fibrous, and elastic substance, which has all the properties of fibrin, and is almost exactly similar to the basis of muscular flesh obtained by long boiling. It may also be procured directly from recent blood, by stirring it, as it flows from the vessel, with a bunch of twigs; or receiving it into a bottle, and shaking it during its coagulation. When formed under these circumstances, it exhibits a fibrous appearance, and the whole is converted into an irregular net-work of dense fibres. Fibrin was formerly known under the name of *coagulable lymph*, or *gluten*.

Red globules.

(392.) The *red particles* or *globules*, contained in the blood, and enveloped in the fibrin during its coagulation, have long attracted the attention of physiologists, from the irregularity of their appearance, and the importance which was supposed to attach to them. The first notice which we find of them occurs in the writings of Malpighi, soon after the introduction of the use of the microscope. They were soon afterwards examined with great care and minuteness by the indefatigable Leeuwenhoek, whose name stands foremost among those who made observations with this instrument. They soon became the subject of much speculation, and laid the foundation of many fanciful hypotheses which were current at the time, but are now consigned to deserved neglect. Leeuwenhoek himself was led by his imagination to the belief that these red globules were each composed of a series of globular bodies of different orders descending in regular gradations. He supposed each to be made up of six particles of serum; each particle of serum of six particles of lymph, and so on in succession. This strange hypothesis, visionary as it now appears, was so accordant with the prevailing taste for mathematical disquisitions, that it was very generally adopted, and held a powerful sway over the opinions and reasonings of the physicians of that age. It forms a leading feature in the pathological speculations of Boerhaave; and although its futility was sufficiently exposed by Lancisi and Senac, it maintained its ground even to the time of Haller.

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[1] On *Animal Heat*, p. 248.

[2] *Physiology*, p. 271.

Their form. (393.) But a better spirit began at length to prevail; the illusive dreams of fancy were superseded by the sober and attentive observation of nature; and truth was sought by the judicious cultivation of experimental inquiry, the only legitimate path by which it can be approached. About the middle of the eighteenth century, the Abbe de la Torré, employing microscopes of considerable power, obtained the appearance of flattened annular bodies, with a perforation in the centre. Hewson, who observed them with still greater attention to accuracy, states them to be hollow vesicles of a flattened shape, and containing a smaller, solid, and spherical particle, which was freely moveable within them, or, as he compares it, "like a pea in a bladder." He asserted, that by adding water, these particles swell out into a globular shape, and afterwards burst and disappear, in consequence of their being dissolved in the water; but if moistened with an aqueous solution of any neutral salt, they preserve their natural flat shape. Cavallo describes them as much more irregular in their form than Hewson represented them; and he was led from his observations to the conclusion that the appearance either of a perforation, or of a central particle, is in reality an optical deception, arising from the refraction of the light by which the objects are viewed, as it passes through the convex surfaces of the globules. He also endeavours to explain the appearance which led Hewson to believe that the central nucleus is moveable within the external vesicle, by some apparent change in the position of the luminous image, in consequence of accidental variations in the direction in which the light is viewed. Very small artificial globules of solid glass which he constructed for the purpose, presented under the microscope very nearly the same appearances as the globules of the blood; and hence he concluded, that the latter, notwithstanding these appearances, were nearly globular and composed of a uniform material.

(394.) Notwithstanding the ingenuity displayed in this reasoning, the more profound examination which the subject has received from Dr. Young, induces us to revert, to a certain extent, to the opinion of Hewson. He observes that in such examinations it is only necessary to employ a full and unlimited light, in order to obtain a very distinct outline of what appears manifestly to be a very simple substance. But we should remember that where the substances to be examined are perfectly transparent, it is only in a confined and diversified light that we can gain a correct idea of their structure. The eye is best prepared for the investigation by beginning with the blood of a skate, of which the particles are, from their greater size, so conspicuous, and of so unequivocal a form, as at once to set aside the idea of a simple homogeneous substance. They are oval and depressed, like an almond, but less pointed, and a little flatter. Each of them contains a round nucleus which is wholly independent in its appearance of the figure of the whole disc, being sometimes a little irregular in its form, seldom deviating from its central situation, but often remaining distinctly visible, whilst the oval part is scarcely perceptible. This nucleus is about the size of a whole particle of human blood, the whole oval being about twice as wide, and not quite three times as long. The nucleus is very transparent, and forms a distinct image of any large object which intercepts a part of the light by which it is seen, but exhibits no inequalities of light and shade that could lead to any mistake respecting its form. But if we place some particles of human blood under similar circumstances, near the confines of light and shade, although they are little, if at all less transparent, we immediately see an annular shade on the disc, which is most marked on the side of the centre on which the marginal part appears the brightest, and consequently indicates a depression in the centre, which De la Torre mistook for a perforation. It is most observable when the drop is dying away, so that the particles rest on the glass; and when a smaller particle is viewed, it has merely a dark central spot, without any lighter central space. Dr. Monro had represented the globules of the blood as being of an exceedingly flattened shape, or, as he expresses it, "as flat as a guinea." But Dr. Young never saw them of this shape, although he states their axis as being sometimes not more than one-third, or one-fourth of their greatest diameter. He also states that they do not seem, as Hewson asserted, to have their dimensions much affected by the fluid in which they are suspended, since they may easily be spread thin on glass, and dried without much change in their magnitude, at least in the direction of the surface to which they adhere; and they remain distinct as long as the access of moist air is completely excluded. When they have been kept for some time in water, and a little solution of salt is added, their form and structure, as Hewson observed, are more easily examined, and appear to resemble those of a soft substance, with a denser nucleus; but the comparison which he makes of their being like a pea in a bladder, Dr. Young thinks is quite inapplicable.

(395.) It has commonly been asserted, and especially by Hewson, that these particles are readily soluble in water; but Dr. Young has shewn that this opinion is erroneous, and depends partly on their passing readily through the filtering paper, a circumstance observed by Berzelius, and partly on the extraction of a great part of their colouring matter, together with which they lose much of their specific gravity, so that instead of subsiding, they are generally suspended in the fluid. Their presence may still, however, be detected by a careful examination; and they seem in this state to have recovered in some measure their original form, which they had lost when first immersed in the water. A curious observation on the influence of circumstances on the form of the globules, has been made by Mr. Bauer. He remarks that in the skate they are oval during the life of the animal, but become flattened after its death. This circumstance may perhaps tend to reconcile some of the discordant statements which have been made on this subject.

Their size. (396.) The size of the red globules has also been very differently estimated by different observers. These discrepancies receive some explanation by the circumstance which Dr. Milne Edwards appears to have established, of the globules differing considerably in their size in the same individual.[1] The most accurate measurements appear to be those of Dr. Young, and of Captain Kater, who both agree that the particles of human blood are between the four-thousandth and the six-thousandth of an inch in their diameter; and they may therefore be taken at a medium at the five-thousandth of an inch. Mr. Bauer has stated them to be considerably larger, even as much as the one thousand-seven-hundredth of an inch in their entire state, and that the central part is the two-thousandth of an inch in diameter. But the observations of Dr. Young are more probably correct, from their coincidence with those of Captain Kater, which were conducted in a different manner.

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[1] *Cyclopædia of Anat.*, art. Blood.

Their colouring matter.

(397.) The difficulty of procuring the red particles in a separate state, unmixed with serum, is so great as to preclude us from obtaining any distinct knowledge of their chemical composition and properties. The colouring matter of the blood has been termed *hematine*, or *hematosine*. But according to M. Lecanu, the substance usually termed hematine is in reality a combination of albumen and the pure colouring matter of the blood, which he proposes to designate *globuline*. Although it appears from Dr. Young's observations, that the globules themselves do not dissolve in water, yet they impart to it the whole of their colouring matter. The watery solution turns syrup of violets green; and after some time deposits a flocculent precipitate, probably from the coagulation of albumen, the presence of which is indicated also by the effect of boiling the solution. Hence it has been concluded that the colouring matter consists of albumen, dissolved by an excess of pure soda. When evaporated and calcined in a crucible, a residuum is obtained, amounting to about one-thousandth of the weight of solid matter, and composed, according to Fourcroy and Vauquelin, chiefly of subphosphate of iron.

Presence of iron.

(398.) Berzelius,[1] who has made minute inquiry into this subject, informs us that the colouring matter of the blood, separated from the other part, leaves one-eightieth of an incombustible residuum, of which rather more than one-half is an oxide of iron. The existence of iron in the blood was first discovered by Menghini; but its amount was much over-rated both by himself and many of the earlier chemists who succeeded him. It is difficult to determine in what state this iron exists in the blood. It would appear not to be in the state of any of the known salts of this metal; because before the blood has been calcined, the iron escapes detection by any of the tests which usually indicate its presence in solutions; and yet the solubility of the colouring matter in the serum would, on the other hand, appear to support the opinion of its possessing saline properties. Berzelius has been able to deduce from his numerous experiments on this point, merely the negative conclusion, that no salt of iron which he tried was capable of being combined with the serum, so as to produce a compound similar to the colouring matter of the blood; thus refuting the alleged synthetic proof adduced by Fourcroy, who had stated that subphosphate of iron dissolves in albumen, and imparts to it a bright red colour, resembling that of blood.[2]

(399.) It has long been the prevailing opinion that the blood derives its red colour from the iron it contains; but the truth of this opinion has been called in question by many writers of high authority, and in particular by Dr. Wells[3] and by Mr. Brande.[4] The experiments of Dr. Wells, however, as is remarked by Dr. Bostock, seem only to prove that the colour of the blood is not occasioned by any salt of iron, or by iron in such a state as to be affected by the ordinary tests. Mr. Brande procured the colouring matter from venous blood in a detached state, by removing the fibrin from it by agitation while it was coagulating, and suffering the red globules to subside in the serum, from which they could be obtained in a concentrated form. Examining this portion by means of different reagents, he arrived at the conclusion, that the colouring principle of the blood is an animal substance of a peculiar nature, susceptible, like the colouring matter from vegetables, of uniting with bases, or mordants, and therefore admitting of being applied in the art of dyeing. The most effectual mordants for the colouring matter of the blood are the salts of mercury, especially the nitrate and bichloride, or corrosive sublimate. On examining the colouring matter distinct from the crassamentum, Mr. Brande did not discover a greater proportion of iron than exists in the other principles of blood. These results, in as far as they relate to the quantity of iron, are at variance with the later and apparently more elaborate experiments of Berzelius, who still maintains that the colouring matter of the blood contains iron, not indeed discoverable by reagents, but decisively proved to exist in its ashes. In every respect, except in containing that metal, the colouring matter agrees with fibrin and albumen; and he seems disposed to believe that its colour, though not depending on the presence merely of an oxide of iron, may be produced by a compound of which the oxide is an essential part.

Vauquelin's experiments[5] may in some respects be deemed to corroborate those of Brande, inasmuch as they show that iron cannot be detected by liquid tests in solutions of the colouring matter; but they at the same time show that this metal is readily detected by these tests in the fluid from which the colouring matter has subsided.

(400.) The changes in the colour of the blood produced by its exposure to different gases, are probably owing to their action on the red globules. Arterial blood is blackened, and venous blood rendered darker, by nitrogen, or carbonic acid gases; but its bright florid hue is restored by exposure to oxygen gas. We shall have occasion to revert to this subject in treating of respiration.

Lymph globules.

(401.) Besides the ordinary red globules, others of a much smaller size have been detected by Mr. Bauer floating in the serum, and even apparently generated while the fluid is under examination. To these Sir Everard Home gave the name of *lymph globules*.[6]

Serum.

(402.) The serum of the blood, or the fluid part which is left after the separation of the crassamentum, is a transparent and apparently homogeneous liquid, of a yellowish and sometimes greenish colour, of a saline taste, and adhesive consistence. Its specific gravity is variable, but may be taken, on an average, at about 1·025. When exposed to a temperature of 160°, the whole is converted into a firm white mass, perfectly analogous to the white of an egg which has been hardened by boiling. It may, in fact, be regarded as identical with coagulated albumen, the chemical properties of which we have already described.

Serosity.

(403.) Although the whole of the mass of serum appears to be rendered solid by the process of coagulation, yet if this coagulum be cut into slices, and subjected to gentle pressure, or if it be placed on the mouth of a funnel, a small quantity of a slightly opaque liquor drains from it, which is called the *serosity*. It has a saline taste, and a peculiar odour, and consists of several ingredients. Its existence as a substance distinct from the albumen was first pointed out by Dr. Butt in 1760, and its properties were farther examined by Dr. Cullen, who speaks of it as a solution of fibrin in water. Hewson believed it to be of a mucous nature. Parmentier and Deyeux published, in 1790, an elaborate set of experiments which they made upon it, from which they drew the conclusion, that the animal substance contained in the serosity was gelatin. This statement seemed so satisfactory, from the apparent accuracy of the investigation, that it was generally acquiesced in. Not only was jelly considered as one of the constituents of the blood, but means were pointed out for ascertaining its proportion; and its supposed agency in the economy was made the foundation of many physiological speculations. But Dr. Bostock has since proved that this opinion is not founded in fact. He was unable to detect the smallest quantity of jelly either in the serosity of the blood, or in any other of the albuminous fluids. In this conclusion he is fully supported by the testimonies of Berzelius, Marcet, and Brande.

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[1] *Medico-Chirurgical Transactions*, vol. iii p. 215.

[2] *Système de Connais. Chymiques*, vol. ix p. 207, 208.

[3] *Phil. Trans.* for 1797, p. 410.

[4] *Phil. Trans.* for 1812, p. 90.

[5] *Annales de Chimie et de Physique*, i. 9.

[6] *Ibid* for 1819, p. 2.

(404.) It may be inferred from the experiments of Mr. Brande, that serosity consists of a small quantity of albumen, still retained in solution by a large proportion of alkali. According to Berzelius, the serosity contains no sulphuric acid, and only a vestige of the phosphoric, and consists chiefly of water, with some pure soda holding albumen in solution, of muriates of soda and of potass, of lactate of soda, and a peculiar animal matter which always accompanies the lactate. Dr. Bostock found the amount of solid contents to vary from the forty-sixth to the seventieth part of its weight, or, on an average, about the fiftieth. It has been a matter of dispute which of the mineral alkalies exists in serum in an uncombined form. Dr. Pearson maintained that it was potass; but Drs. Bostock, Marcet, and Berzelius, with much greater appearance of correctness, allege that it is soda.

(405.) The component parts of human serum, according to the analysis of Dr. Marcet, are—

Water,....................................	900·
Albumen,..................................	86·8
Muriates of potass and soda,...........	6·6
Muco-extractive matter,................	4·
Subcarbonate of soda,....................	1·65
Sulphate of potass,......................	·35
Earthy phosphates,......................	·6
	1000·

(406.) This analysis coincides very nearly with that of Berzelius, who considers the substance termed by Dr. Marcet *muco-extractive matter* to be impure lactate of soda. But Dr. Bostock is led by his experiments to the conclusion, that a peculiar animal substance exists in the serosity, not coagulable by heat, or by any other means; not affected by corrosive sublimate, or by tannin, which are the appropriate tests of albumen and of jelly respectively, but copiously precipitated by muriate of tin, and still more readily by the acetate of lead; and he thinks this substance is quite independent of the lactate of soda, which may exist at the same time in the blood.

zome

(407.) Wienholt discovered that the serosity contained a small quantity of the peculiar substance which exists in greatest abundance in the flesh of animals, and was first noticed as a distinct proximate principle by Rouelle. It was subsequently termed *ozmazome* by Thenard, who examined its properties more minutely. This substance is of a yellowish brown colour; it is soluble both in water and in alcohol, and is precipitated by infusion of nutgalls, nitrate of mercury, and by the acetate and nitrate of lead. It is still a matter of uncertainty what connexion exists between this substance and the muco-extractive matter above mentioned. There is also another proximate principle, namely, *urea*, of which we shall afterwards have occasion to speak, which is found in small quantity in the blood, when that fluid is in its natural state, but which is abundantly found in the blood of animals from which the kidneys have been removed. Besides these, Dr. B. Babington discovered the presence in the blood of an oily substance, separable from the other parts by means of ether. Lecanu, in addition to this oily matter, found a crystallizable fatty matter in the blood; and similar observations have been made by Chevreul. Manganese is said to have been detected in the blood by Wurzer. M. Boudet has also lately discovered a new substance in the serum, which he has termed *uroline*. This is a white, slightly opalescent substance, fusible at 94° Fahrenheit, not forming an emulsion with water, soluble in alcohol, not saponifiable, and apparently containing nitrogen.

CHAP. VII. CIRCULATION.

Sect. I.—*Apparatus for Circulation.*

Purposes answered by the circulation.

(408.) The object of the function of circulation is twofold. The first is to distribute to all the organs that due share of nutritive fluid which they require for the performance of their respective offices, for the maintenance of their temperature, and for nutrition, and to keep up a constant supply of this fluid. The second, and no less important object, is to expose every portion in succession of this fluid, which is the blood, to the influence of atmospheric air in an organ appropriated to this particular purpose; the continual renewal of the action of the oxygen contained in the air upon the blood, being necessary for the maintenance of its salutary qualities, and indispensable to the preservation of life. The organs in which this process is carried on are the *lungs;* and the function by which it is accomplished is *respiration.* The great agent for the distribution of the blood both generally to the organs of the body, and specially to the lungs, is the *heart;* the pipes through which it is conveyed to those parts are the *arteries;* those through which it is brought back to the heart, the *veins.* A set of finer vessels interposed between the minute extremities of the arteries, and the minute beginnings of the veins, are called the *capillaries.* The structure and distribution of all these parts, have already been described in the treatise on ANATOMY, to which we of course refer for the descriptive details. The following brief recapitulation, however, of the structure of the heart will assist us in understanding the physiology of its action.

1. *Cardiac Apparatus.*

Heart.

(409.) The heart is a hollow muscle, of a conical shape, occupying the central and inferior part of the cavity of the thorax, having its *basis* turned towards the right side, and its point or *apex* towards the left, nearly opposite to the space between the sixth and seventh ribs. Its lower surface is somewhat flattened, where it lies upon the diaphragm. Its basis, with which the great vessels are connected, is covered with fat. The whole heart, and the roots of the large blood-vessels at its basis, are protected by a general investment of membrane, which is a reflected production of an extended serous membrane, forming a cavity for its reception, and for allowing it considerable freedom of motion. This membrane, which is remarkable for its strength, is called the *pericardium,* and is situated between the laminæ of the mediastinum, which are separated in order to contain it.

Its cavities.

(410.) The heart is principally made up of muscular fibres, the course of which is extremely complex; some extending longitudinally from the basis to the apex, others taking an oblique or spiral course; and a third running in a more transverse direction. There are two considerable cavities, called *ventricles,* distinguished, according to their situation, into the right and left ventricle. The former has also been called, in reference to its functions, the *pulmonic,* and the latter the *systemic* ventricle. They are separated by a strong and thick partition, called the *septum ventriculorum,* which is composed of fleshy and tendinous fibres. Attached to these, at the basis of the heart, are two hollow and fleshy projecting appendages, called the *auricles,* the cavities of which are also separated from each other by a partition, distinguished by the name of *septum auriculorum,* and they open into those of the ventricles. The right auricle, which, together with the right ventricle, is placed

Its valves.

more in front, receives the blood from the venæ cavæ, and transmits it to the right ventricle, by which it is propelled into the trunk of the pulmonary artery. The left auricle, in like manner, collects the blood from the four trunks of the pulmonary veins, and transfers it into the left ventricle, by which it is forcibly driven into the aorta, or main trunk of the arterial system of the body at large. The membrane which lines the cavities of the heart, and the great vessels just mentioned, is produced so as to form valves at the two orifices of both the ventricles; that is, where the auricles open into them, and also at the origin of the arterial trunks which arise from the ventricles. The valves placed between the right auricle and ventricle, are usually three in number, and are called *valvulæ tricuspides;* but in the left ventricle there are only two, and these are named the *valvulæ mitrales.* The membranes which form these valves are attached so as to project somewhat forward in each of these cavities, and are connected with tendinous strings, called *chordæ tendineæ*, which arise from detached and projecting portions of the muscular substance of the heart, named from their cylindrical form, *carneæ columnæ.*

(411.) The valves at the origin both of the pulmonary artery and of the aorta, are three in number, and are called the *valvulæ semilunares*, from their semicircular figure; their convexities are turned towards the ventricle; they are concave next to the cavity of the artery; and in the middle of their loose edge is found a small hard triangular substance called *corpus aurantianum*, and sometimes *corpusculum Morgagni*, or *sesamoideum.* When these valves are made to approach each other, by the pressure of the blood in the artery in the direction of the ventricle, they unite so as completely to close the passage, and prevent any of the blood from returning. Opposite to the semilunar valves, the artery bulges out and forms three projections, which have corresponding pits or depressions within, and are called, from their discoverer, *sinus Valsalvæ.*

(412.) Where the two venæ cavæ meet, there is a small angular projection, which has been called the *tuberculum Loweri.* The term *auricula* more properly applies to the jagged portions which project from the sides of the base of the heart, like the ears of a dog from its head; whilst the expanded cavity where the venous tubes enter is called the *sinus venosus.* On the side next to the auricula, there is a remarkable semilunar fold, projecting within the cavity, between the vein and auricle, so as to be convex next to the vein, and concave next to the auricle. This doubling has been called the *Eustachian valve.* Between the concave part of this fold, and the opening into the ventricle, is the orifice of the coronary vein, which returns the blood that has circulated through the substance of the heart itself, and which is provided, at this point, with its proper valves. In the septum auriculorum is seen a depression, the *fossa ovalis*, which is the remains of a passage of communication between the right and left auricles that had existed in the fœtal state. The sides of the fossa ovalis are strong and thick, and have received the name of *isthmus Vicussenii*, or *columnæ*, or *annulus fossæ ovalis.*

2. *Sanguiferous System in general.*

Sanguiferous system. Double circulation.

(413.) The blood-vessels, consisting of arteries. veins, and capillaries, compose by their assemblage what is termed the *sanguiferous system;* and the channels which they form for the transmission of the blood constitute a double circuit. The principal circuit consists of that through which the blood is distributed to all parts of the body indiscriminately, and which includes therefore the whole system. But there is also another circuit of lesser extent, which is performed by the blood, by its being sent from the heart to the lungs, and again returned to the heart, after circulating through those organs. This is termed *the lesser circulation,* by way of contrast with the circulation through all the rest of the body, which constitutes *the greater circulation.* For effecting this lesser circulation, a distinct set of blood-vessels, namely, the *pulmonary vessels*, is provided.

(414.) Thus, there are two separate systems of blood-vessels, which have no communication with each other, except through the medium of the heart, which is the common origin and termination of both. The *aortic system*, or, as some modern anatomists have chosen to designate it, the *systemic system*, is that which, taking its rise from the left ventricle of the heart, begins with the *aorta*, or main trunk of the arteries which transmit the blood to the body at large, and is completed by the veins which are collected into two trunks, called *venæ cavæ;* which trunks, again, terminate in the right auricle of the heart. The *pulmonary system*, on the other hand, comprises the pulmonary arteries, which arise by a single trunk from the right ventricle of the heart, and after circulating the blood through the lungs, are continued into the pulmonary veins, and terminate by four large trunks in the left auricle of the heart.

Coats o the vesse

(415.) All these vessels, whether arteries or veins, may be comprehended under the following general description. They are flexible and elastic tubes, for the most part of a cylindrical shape, and composed principally of a membranous or fibrous structure formed into distinct layers, and composing what are called the *coats* of these vessels. The number of these coats has been differently estimated by different anatomists; but it is now generally agreed that those proper to the vessels themselves are principally three: the *external*, the *internal*, and the *middle*, or what has been called the *muscular* coat. Besides these tunics, each vessel is surrounded by a loose and flocculent cellular substance, which connects it with the parts through which it passes, and accompanies it in its whole course; but this substance, being merely a continuation of the cellular substance which fills up all the vacuities of the body, is common to the vessel and to other parts, ought not properly to be considered as belonging to the former, but as adventitious; although some anatomists have dignified it with the title of the *cellular coat.*

(416.) The first proper coat of the vessel is the external coat, which is thicker than the rest, and formed of a membranous structure, in which are intermixed a few filaments of fibro-cellular substance, disposed obliquely with respect to the course of the vessel, and interwoven with the membranous fibres. The innermost membrane is thinner than the former, of a whiter colour, more or less pellucid, and presenting a more uniform homogeneous structure. Its inner surface is perfectly smooth, and much resembles in appearance the serous membranes. Between these membranous coats, there exists a layer of fibres, which have been generally supposed to be muscular, constituting what has been accordingly called the *muscular coat.* Compared with the diameters of the vessels, these coats are proportionably thicker in the smaller than in the larger vessels.

(417.) After giving this general description of the structure of the blood-vessels, we proceed to notice some of the peculiarities which distinguish each class of blood-vessels.

3. *Arterial System.*

Structur of arteri

(418.) Each of the great arterial trunks, belonging respectively to the aortic, and to the pulmonic systems, are furnished, at their origin from the ventricles of the heart, with valves of a semilunar shape, adhering by one of their sides to the margin of the aperture of the ventricle, or mouth of the artery, and having their loose edges turned towards the axis of the artery. These valves are formed by a duplicature of the internal coat, which contains between their folds a thin layer of ligamentous fibres, giving them considerable strength. No valves are found in any other part of the arterial system.

(419.) The external coat of an artery is formed by a dense tissue of fibres, which are interwoven together in different directions, generally very obliquely with regard to the length of the vessel. This texture becomes more compact as we trace it towards the interior, so that the individual fibres can with difficulty be distinguished, unless by a forcible tearing asunder of the substance they compose. Hence the older anatomists have distinguished this inner layer of the external coat, as forming a separate tunic, to which they have given the name of the *nervous coat*, implying thereby a participation in the structure of tendons which were not at that time distinguished from nerves. The division of the external coat into these two layers, is well marked in the larger arteries; but in proportion as we examine the smaller branches, we find a more uniform appearance, the whole assuming the firm and compact texture of fibrous membranes. This portion of the arterial structure is exceedingly strong and elastic, both with respect to a force stretching it in the direction of its length, and also transversely, or in that of its diameter. Its toughness is such that it is not easily cut asunder by a thread employed as a ligature upon the vessel.

(420.) The intermediate, or muscular membrane, is of considerable thickness, has a yellow colour, and is composed of fibres, all of which are arranged circularly; that is, in the circumference of the cylinder. In the large arterial trunks, these fibres form a distinct layer or tunic; but the membrane acquires a still greater proportional thickness in the smaller branches, and then admits of subdivision, by dissection, into several layers. The exterior layers are less dense than the interior; and those which are innermost are the densest of all. The elasticity and firmness of this coat is chiefly in the direction of the circular fibres of which it consists; so that it opposes considerable resistance to any force which tends to dilate the vessel, but yields readily to any power applied for its elongation. It may be considered as partaking of the properties of muscular and ligamentous structures.

(421.) The internal membrane of arteries, which has also been called the *nervous*, *arachnoid*, or *common coat*, is the thinnest of the three; although still, in the larger arteries, it admits of division into two or more layers. The innermost of these is extremely thin and transparent, and its surface is smooth and highly polished, in order that no resistance may be opposed to the motion of the blood. The outer portions are white and opaque, and pass gradually into the substance of the muscular tunic with which it is connected. Its elasticity is very small, and its power of resistance is limited, so that a ligature applied on the vessel generally produces a laceration of the internal coat.

ribu-
of the
ries.

(422.) The general form of the arterial system, if it were isolated from all other parts, would resemble two trees, the trunks of which would be constituted by the aorta, and by the pulmonary artery, and which divides and subdivides successively into smaller and smaller branches, till they arrive at an extreme degree of tenuity. Each portion which intervenes between these divisions preserves the same uniform diameter, and is therefore exactly cylindrical. Each branch is of course smaller than the trunk from which it arises; but the sum of the areas of all the branches into which an artery divides itself, is in general greater than the area of that artery; and consequently the total capacity of the arterial system is progressively increasing in proportion to the number of subdivisions which take place. Hence the whole system may in reality be considered as composing a conical cavity, of which the aorta is the apex, and the ultimate subdivisions the base. The number of subdivisions in the whole course of an artery scarcely ever exceeds twenty, according to the estimate of Haller, who took pains to ascertain this point. The most usual mode of ramification is that of bifurcation, or division of a trunk into two branches, which generally form between them an acute angle. In some instances, especially among the larger arteries, we meet with a branch sent off at right angles from the main trunk, or still more rarely at an obtuse angle.

Anastomoses.

(423.) Arteries have numerous communications among their different branches. These communications, or *anastomoses*, as they are called, are effected sometimes by the reunion of two arteries of nearly equal size, which happen to be proceeding in similar directions, so as to compose one common trunk, which proceeds in an intermediate direction, sometimes by collateral branches proceeding obliquely from the one to the other; while on other occasions, arteries unite from greater distances, so as to form a wide arch, in which each appears to be continuous one with the other; and from the convex side of which, branches are again sent off, which are distributed in minuter ramifications. In some parts the anastomoses are so frequent and numerous, as to resemble a net-work, or plexus of vessels.

(424.) The principal arteries of the limbs are generally found running in situations where they are best protected from injury, and where they are most secure from pressure during the actions of the muscles. Hence they are chiefly met with in the hollow spaces formed on the inner side of the flexures of the joints.

4. *Venous System.*

Veins.

(425.) The chief peculiarities in the structure of the veins, as distinguished from that of the arteries, consist in the greater thinness, and diminished density of their coats, the tenuity or absence of the muscular tunic, and the numerous valves which occur in different parts of their course. The outer coat resembles that of the arteries, but does not present so dense or so fine a texture of fibres; and it possesses less absolute strength. The middle coat is formed of fibres which are more extensile and flexible than those of arteries; and their direction, instead of being transverse, is principally longitudinal. These fibres are not constantly met with in all the parts of the venous system, but vary much in their proportion to the rest of the structure in different veins, as well as in their directions and thickness. It is only in the large veins, near the heart, that this coat presents any appearance of muscular fibres. The inner coat is thin and transparent, like that of the arteries; but differs from the latter in being more extensible, less easily torn, and in its containing a certain proportion of ligamentous fibres in its composition. Some of the veins, such as those within the cranium, which are called *sinuses*, as well as the veins which traverse the bones, being protected by the surrounding parts, appear to consist altogether of this inner coat, and are unprovided with either the muscular or the cellular coats.

(426.) The large veins follow in general the course of the arteries, but are usually twice as numerous; so that where we meet with an artery, we generally find it accompanied by two veins. Their general disposition is arborescent, like the arterial system; but with reference to the function they perform, they may be more aptly compared to the roots than to the branches of a tree; for in following the course of the blood in its circulation, they may be said to take their rise from the minutest vessels, and successively uniting into larger and larger tubes, to terminate by one or two main trunks in the heart. The total capacity of the venous system is at least twice as great as that of the arterial system. The distribution and general mode of ramification of the veins, correspond very exactly to that of the arteries, presenting the same ramified appearance, and the same frequent anastomoses. These collateral communications are exceedingly numerous in the superficial veins, and wherever they are liable to partial obstruction from external pressure. It is in these situations also, that we meet with a great number of valves in the course of the veins. The veins of the deep-seated organs are generally unprovided with valves in any part of their course. The arteries, as we have already seen, have no valves except at their commencement.

Portal system.

(427.) Besides the two venous systems appropriated to the greater and lesser circulations, the former uniting in the venæ cavæ, and the latter in the pulmonary veins, and therefore corresponding to the two arterial systems, there is also another, and more partial system of veins, peculiar to the circulation in the liver, and other viscera of the abdomen. This particular system, which is that of the *vena portæ*, as it is called, is complete within itself; that is, it constitutes a tree, having a common stem, with its proper roots and branches, the whole of which is placed as an intermediate system between the ultimate branches of the gastric, intestinal, and splenic arteries, of which the roots of the vena portæ may be considered as the continuations, and first radicles of the proper hepatic veins, which are the continuations of the ultimate ramifications of the vena portæ. By this arrangement, the blood which has circulated through the stomach, the intestines, and the spleen, is distributed by a new set of veins, throughout the substance of the liver, and is returned to the general mass of blood in the venæ cavæ, after circulating through that organ.

To this peculiar venous system there is no corresponding arterial system.

5. *Capillary System.*

Capillaries.

(428.) The ultimate ramifications of the arteries, as well as the beginnings of the veins, are, in almost every part of the body, vessels of such extreme tenuity, as to be imperceptible without the assistance of the microscope; and they cannot even then be discerned, unless the part be artificially prepared by the injection of some coloured substance into the vessels, or unless they have been accidentally enlarged by disease, so as to have received the colouring matter of the blood. Hence the ancients, who were ignorant both of the art of injecting, and of the power of the microscope, were precluded from a knowledge of the existence of these minute vessels. They believed that a substance, which they termed *parenchyma*, and which they conceived to be of a spongy texture, was interposed between the terminal branches of the arteries, and the beginning of the veins; and this opinion was adopted almost universally by anatomists before the epoch of the discovery of the circulation, and was entertained even after this period, by a great number of eminent anatomists, down to the present day. But the injections of Ent, and the microscopical observations of Malpighi and of Leewenhoek, have sufficiently demonstrated the continuity of the canals by which the blood is made to pass from the arteries into the veins. The researches of modern anatomists, indeed, by shewing the amazing extent to which the minute division of the vascular system is carried, and in which they pervade every part of the frame, have finally exploded the hypothesis of the existence of interposed parenchyma, and have given rise to another hypothesis of an opposite kind, namely, of all the textures of the body being ultimately resolvable into vessels.

(429.) The name of *capillary vessels* is given to those minute branches of either arteries or veins, whose diameter is finer than a hair, and which can therefore scarcely be distinguished by the unassisted eye. Authors have endeavoured to establish three gradations of size in this class of vessels; the largest being those which can be but just perceived by the eye without a magnifying glass; the next, those which require the aid of the microscope for their detection; and the third, those which are capable of admitting only a single red globule of blood, and of which the calibre must consequently be only a very little larger than these globules.

(430.) The larger capillaries undergo several subdivisions in their course, before they arrive at this extreme degree of tenuity; and indeed, their lateral branches of communication are so multiplied as they proceed, that the whole forms a general and extensive net-work of vessels. The total capacity of the capillary system far surpasses that of the arteries and veins; and they contain therefore by much the greatest portion of the blood in the natural and healthy state of the circulation.

(431.) The vascular branches which form the channels of communication between the arteries and the veins, are, with but very few exceptions, referable to the class of capillary vessels. In this continuous course it is scarcely possible to mark with precision, at what point the arterial portion may be said to terminate, and the venous portion to commence. Neither the limit of size, nor the change of direction, is sufficient to lay the foundations of such a distinction; for the alteration of diameter is gradual, and the inflexions are various, and frequently tortuous, so that no determinate criterion can be assumed as characteristic of either artery or vein. Hence arises the propriety of constituting a distinct class of capillary vessels.

(432.) The texture of the capillaries, from the minuteness of their size, scarcely admits of accurate observation. Their coats are thin, soft, pellucid, and therefore invisible to the naked eye, and hardly discernible with the microscope. It is most probable that they are formed, in every instance, by a prolongation of the internal coats of the larger arteries and veins with which they are continuous.

Serous capillari

(433.) As the capability of admitting coloured substances is apparently an indispensable condition for their being visible, the existence of vessels of still smaller diameter, containing only colourless fluids, must more or less be matter of conjecture. A very great number of anatomists and physiologists, however, among whom may be enumerated Boerhaave, Vieussens, Farricnus, Haller, Soemmerring, Bichat, Bleuland, Chaussier, have admitted the existence of another order of capillaries, or *serous vessels*, as they have termed them, of which the diameter is too small to admit even a single red globule, and which therefore circulate only the serous part of the blood. On the other hand, the reality of these pretended vessels is contested by Prochaska, Mascagni, Richerand, and others. Béclard, in his *Anatomie Générale*, has given a review of the arguments employed on both sides in this controversy, which is by no means as yet set at rest, and which will probably have to be decided, more by considerations of a physiological than of an anatomical nature.

Erectile tissues.

(434.) In speaking of the communications between the arteries and the veins, it remains only to be noticed, that in many parts of the body there appears to be interposed between the extreme branches of each, a spongy or cellular structure, into which the arteries occasionally pour out blood, so as to distend these cells, and from which the veins arise by open orifices, and absorb the blood, in order to unload the cells, and remove the accumulation which has taken place. Such a structure has been denominated the *erectile tissue*. It is exemplified on a large scale, in the spleen, and in some of the sexual organs. We shall notice this structure afterwards.

Vascula of differ parts.

(435.) The different parts and textures of the body are supplied with vessels in very different proportions. The organ which ranks first in respect to its vascularity, is the lungs; after which come the integuments, the pia mater, and choroid coat of the eye; next the glands, the glandular follicles, the lymphatic glands, the cortical substance of the brain, the nervous ganglions. To these will succeed in the order of vascularity, the muscles, the periosteum, the adipose tissue, the medullary nervous substance, the bones, and the serous membranes. The tendons and ligaments are amongst the least vascular parts. Still less so are the cartilages, and the arachnoid membrane of the brain; and lastly, the epidermis, and its appendages, as the nails and hair, together with the enamel of the teeth, may be considered as parts entirely devoid of vessels.

uantity f blood.

(436.) The actual mass of blood which the organs of the circulation have to move through the channels we have just pointed out has been variously estimated by different physiologists. The lowest computation is that of Müller and Abeildgaard, who made it out to be only eight pounds. Borelli estimated it at twenty pounds; Planche at twenty-eight; Haller at thirty; Dr. Young at forty; Hamberger at eighty; and Keill at one hundred. Blumenbach states the proportion in an adult healthy man to be one-fifth of the entire weight of the body; but Dr. Good, who has collected these authorities, is disposed to place but little reliance on the latter mode of estimation, on account of the great diversity in point of weight and bulk of adults, whose aggregate quantity of blood would appear to be nearly the same. He thinks the mean of the above numbers, which is between thirty and forty pounds, may safely be taken as nearest to the truth. The proportion of the whole mass of blood which is contained in different parts of the vascular system, varies according to age. In early life, there is nearly an equal quantity contained in the arteries as in the veins. In the adult, one-fourth only is contained in the arterial, and three-fourths in the venous system; and the disproportion is greater as age advances.

Sect. II.—*Phenomena of the Circulation.*

1. *Course of the Blood in its Circulation.*

ourse of e blood.

(437.) Having premised this general outline of the course which the blood takes during its circulation, we shall now follow the several steps more in detail, examining, as we proceed, the evidence afforded us that such is its real course; and we shall lastly inquire into the several powers concerned in its propulsion.

ffice of e heart.

(438.) We shall, for this purpose, begin at that part of its circuit at which the blood is brought back from the lungs, after receiving the vivifying influence of the air, and being thereby *arterialized*, as it has been called. The pulmonary veins, which convey it in this state to the heart, are collected into four great trunks, which open into the left auricle of the heart. As soon as the auricle is distended beyond a certain degree by this flow of blood into it, it contracts and pours the whole of its contents at once into the left ventricle. The constant stream of blood which is flowing towards the auricle from the lungs, prevents any portion of the blood of the auricle from flowing back into them when the auricle contracts. No sooner has the ventricle received this blood, which has passed into it by a sudden influx, than it is stimulated to a vigorous contraction of its muscular fibres, which, surrounding the cavity in a spiral direction, contract its cavity, and, exerting a powerful pressure on the contained fluid, propels it with prodigious force into the aorta. The contraction of the ventricle is attended with the raising of the mitral valve, interposed between it and the auricle, and the sides of that valve being closely applied to the aperture by which the blood had entered the ventricle, all return of the blood into the auricle is thereby prevented. The whole of it rushes, therefore, as an impetuous torrent into the aorta, or main trunk of the arterial system. The blood which has entered the artery is again prevented from flowing back into the ventricle, by a valvular apparatus of the same kind as that which occurs between the auricle and the ventricle. These valves, placed at the entrance of the aorta, are called the *sigmoid*, or *semilunar valves.* They are three in number, each being attached by its convex edge to the coats of the artery, to which it is closely applied when the stream of blood is flowing in a direction from the heart, but which is immediately raised, and the three loose edges joining together, form a complete barrier to the passage of the blood when moving in the contrary direction.

stemic ulation

(439.) The blood, having passed into the aorta, is conveyed through its branches and ramifications to all the parts where these ramifications extend, till it reaches the capillaries, where it moves more slowly, yet still proceeds on its course, supplying every part with the materials necessary for the maintenance of their nutrition and vital powers. From the capillaries the blood is brought back by the minuter branches of the veins, which, uniting successively to form larger and larger trunks, are at length collected into the two venæ cavæ, the one descending from the head and superior parts of the body, and the other ascending from the inferior parts, and both joining at the right auricle of the heart. The same process now takes place in the right cavities of the heart, which was described as occurring in the left. The right auricle is filled with blood from the venæ cavæ; it contracts and pours its contents into the cavity of the right ventricle, which, being in its turn stimulated to contract, propels the blood it had received from the auricle into the trunk of the pulmonary artery; which artery likewise distributes it, by a similar system of ramifications, to the membrane lining the air vesicles of the lungs. All retrograde motion of the blood is prevented as effectually in this case as in the former, by the interposition of the tricuspid valves between the auricle and ventricle, and by the semilunar valves placed at the entrance of the pulmonary artery.

Pulmonary circulation.

(440.) From the ultimate ramifications of the pulmonary artery the blood is conducted into the capillary vessels, which are spread over the membrane of the air-cells of the lungs, where it undergoes the change of quality from venous to arterial, consequent upon its exposure to the chemical action of the oxygen which is contained in the atmospheric air admitted into those cells. From these capillaries it is collected by the pulmonary veins, and returned, as before stated, to the heart, to be again distributed to every part of the body.

Systole and diastole.

(441.) While one portion of the blood is circulating in the system, another portion is circulating in the lungs. Both auricles are filled at the same moment, and contract together; each sending its blood into the corresponding ventricle. In like manner, the two ventricles contract simultaneously, and propel their contents into their respective arterial trunks. The contraction of the heart is called *the systole;* its relaxation *the diastole.*

2. *Proofs of the Circulation.*

Discovery of the circulation.

(442.) The discovery of the course which the blood takes in its circulation, a discovery of such vast magnitude, that almost the whole of the present doctrines of physiology and pathology are either directly founded on it, or are more or less immediately related to it, was made in the beginning of the seventeenth century. It was one of the earliest fruits of that active spirit of inquiry, and rational process of investigation, which, since the era of Bacon, was beginning to diffuse itself in Europe. It was an honour reserved for our illustrious countryman Harvey, whose fame must live as long as science is cherished among men. While it is the fate of other discoveries, that their authors are either soon forgotten, or only known to a small class of those who devote their attention peculiarly to the subject to which they relate, the name of Harvey is become familiar to all who have any acquaintance with general literature, or pretensions to a liberal education. However firmly the truth of his great discovery be established in the present time, it was, in its first promulgation, keenly contested by many contemporary physiologists. To us who have no such prejudices to warp our judgment, and who are furnished with so large a body of evidence on the subject, the controversy appears exceedingly frivolous and absurd. Yet we must recollect that in every subject of human opinion, it requires a considerable time to wean mankind from errors which have been long and deeply rooted in their minds, however palpable such errors may appear to the eyes of those who have not been so blinded. As it may still, however, be satisfactory to know the grounds upon which the doctrine is founded, we shall briefly enumerate the leading facts and arguments that establish it.

Proofs of the circulation. 1. Ligatures.

(443.) The most striking proofs that the course of the blood along the arteries is from the heart towards the extremities of those vessels, and along the veins in the contrary direction, are obtained from ligatures on those vessels. If any of the larger arterial branches be tied, that portion of the vessel which is situated between the ligature and the heart, immediately swells, becomes distended with blood, and exhibits strong pulsations; and if while in this state it be punctured, the blood rushes out with violence, and in successive jets, corresponding to the pulsations of the heart. The part beyond the ligature, on the other hand, or that farthest from the heart, is flaccid and empty, and affords no blood when divided; it is also void of pulsation. Phenomena precisely the reverse of these are exhibited when similar experiments are made on the veins; in them, the part most distant from the heart becomes turgid, while the nearer part is empty. This last experiment is one that is made every time a person undergoes the operation of blood-letting. A ligature is applied round the arm, from the pressure of which on the subcutaneous veins, they are made to swell every where below the ligature, that is, farther from the heart; while all the veins above the ligature are empty, the blood having been propelled onwards in its course towards the heart. Those parts which are swelled pour out their blood profusely on being punctured; and when the bandage is removed, the flow is stopped, in consequence of the blood finding a ready passage to the heart.

2. Valves.

(444.) In the veins, we have additional evidence, from the structure of the valves, that the blood can move only in one direction, namely, towards the heart. The valves at the entrance of the ventricles and arterial trunks, which allow of motion only in a particular course, lead to a similar conclusion with respect to the direction of the current in its passage through the heart. It is impossible by artificial means to force fluid injections through the heart, in a course contrary to that in which the blood moves; and the same insuperable resistance is experienced in the attempt to pass injections in other parts of the circulating system, when in opposition to the natural course taken by the blood, while the same fluids readily find their way from the arteries into the veins, when thrown in that direction.

3. Microscopic observation.

(445.) Ocular demonstration of the course of the blood while circulating in the smaller arterial and venous branches, and also in the capillaries, is afforded by the microscope, when a very thin and transparent membrane in which such vessels are distributed is placed in the field of a good microscope. The web between the toes of a frog, the surface of its vesicular lungs, the mesentery, the membrane in the tail of small fishes, are all of them capable of exhibiting these phenomena, and present, indeed, a spectacle of the highest interest.

4. View of the heart.

(446.) The successive action of the cavities of the heart, in the order above enumerated, may also be seen when the hearts of living creatures are exposed to view; and this spectacle may be afforded without pain to the animal, if, after its head has been completely separated from the body, respiration be kept up by artificial means.

5. Transfusion of blood.

(447.) The transfusion of the blood of one animal into the vessels of another is a curious illustration of the doctrine of the circulation. In this operation, the artery of one animal is connected by a tube with the vein of another animal; the consequence of which is that the first is gradually emptied of its blood, while the vessels of the other are in a state of repletion. If an opening be made at the same time in the veins of this second animal, the blood originally belonging to it will escape, and thus the whole mass of its circulating fluid will be changed. Experiments of this kind were at one time very common, but they have long ceased to excite curiosity, and are now rarely practised.

6. Wounds of vessels.

That the blood moves with great rapidity and force through the larger vessels, is proved by the immense quantity that is quickly lost if any great artery or vein be wounded.

Sect. III.—*Powers concerned in the Circulation.*

(448.) We have next to enquire into the nature and magnitude of the forces by which the blood is impelled in its course, the resistance opposed to its progress, and the general laws by which its movements are regulated.

(449.) The subject will naturally divide itself into four parts; namely, as relating to the powers of the heart, of the arteries, of the capillaries, and of the veins.

1. *Action of the Heart.*

Action of the heart.

(450.) The intention and purpose of the auricles, which are placed as ante-chambers to the ventricles, is to receive the blood in a constant stream from the veins, which fill it gradually and equably, so that when the distension has reached a certain degree, the auricle may contract and discharge the whole of its contents, with a sudden impetus, into the ventricle. The thickness and muscular force of the auricles are very inferior to those of the ventricles, which being destined to propel the blood with considerable momentum into the arterial system, are exceedingly powerful, but seem to require the stimulus of a sudden and forcible distension, in order to excite them to a sufficiently energetic action. It appears, indeed, that this mechanical distension and separation of their sides from the influx of fluid, is the natural stimulus that excites them to contraction; for they are not affected by any of the causes which produce contractions in the voluntary muscles, such as irritation of the nerves which supply the heart. On the other hand, the mere introduction of warm water into these cavities, when previously emptied of blood, is sufficient to renew the action of the heart.

Absolute force of the heart.

(451.) It is exceedingly difficult to form any probable estimate of the absolute force exerted by the heart, and more particularly by the left ventricle, in propelling its contents. No inquiry in physiology was pursued with more ardour, has been the subject of more various controversy, or has given rise to so many voluminous and elaborate calculations.

(452.) It will be quite evident that a very considerable power is required, in order to enable the heart to propel the blood through the arteries, when we consider the enormous resistances opposed to its progress, and when we also take into account the great velocity given to it in its motion. The column of blood already contained in the arterial system, must have its velocity accelerated, in order to admit of the passage of fresh blood into the aorta. The arteries require also to be distended for the admission of this additional quantity of blood, every time that the ventricle contracts. The angles and flexures which the blood is obliged to follow in its course through the vessels, must be causes of retardation, and must be productive of a loss of force, which the muscular power of the heart is ultimately called upon to supply. The operation of all these retarding causes is so complicated, that we need not be surprised at the problem of the force exerted by the heart, having baffled the skill of the best mathematicians, and their calculations being so widely different from one another. Thus, while Keil estimated the power of the left ventricle at only five ounces, Borelli calculated that its force could not be less than one hundred and eighty thousand pounds. Dr. Hales computes it to be exactly fifty-one pounds and a half; while Tabor concludes its amount to be one hundred and fifty pounds. Such irreconcilable results sufficiently show the futility of most of the reasonings on which they are founded, and the impossibility of making any satisfactory approach towards the solution of the problem. We should, on the whole, be more disposed to place confidence in the estimate of Hales, who moreover states, that the velocity with which the blood passes into the aorta, is about one hundred and fifty feet per minute, or two feet and a half per second; and that the quantity of blood passing through the heart during each hour, is about twenty times the whole mass of blood contained in the body; or, in other words, that the whole mass completes twenty entire circulations in an hour. The great velocity of the blood in the vessels is exemplified by the fact, that a fluid introduced into one of the jugular veins of a horse, has been detected in the opposite vein, and even in the vena saphena of the leg, in the course of half a minute.

(453.) It has been keenly disputed whether the heart is able completely to empty its cavities at each contraction; and the question, which is not one of any real importance, is hardly yet decided.

(454.) Another subject of controversy which was much agitated among the French physiologists in the middle of the last century, is, whether the heart is shortened or elongated during its systole; that is, whether the apex approaches the base during the contraction of the ventricle, or recedes from it. From the numerous observations of Spallanzani, as well as of other experimentalists, there seems to be no doubt that during the systole all the parts are brought nearer to the tendinous ring surrounding the auriculo-ventricular orifices, which may be regarded as the fixed pivot of its movements, and consequently the length, as well as the other diameters of the heart, is shortened. During this action, however, the curvature being suddenly straightened, the apex is projected forwards, and produces that striking against the ribs which is felt by the hand applied externally to the chest.

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(455.) The right ventricle having only to perform the lighter task of circulating the blood through the lungs, is much inferior in thickness and strength to the left ventricle, which has to propel the blood through the whole aortic system, forming a course of much greater magnitude than that of the pulmonary vessels. But, on the other hand, the capacities of the two ventricles are nearly equal, as might be expected, when it is considered that the same quantity of blood which is forced out from the one, must, in the course of circulation, pass through the other; and that both the ventricles contract the same number of times in a given interval. The quantity of blood expelled by the heart at each contraction, is estimated by Blumenbach at two ounces. So that, reckoning the whole mass of blood at thirty-five pounds, or four hundred and twenty ounces, and the contractions to be repeated seventy-five times in a minute, the whole of the blood will have passed through the heart in about three minutes; thus agreeing very nearly with the estimate of Hales already stated, (§ 452.)

ritability the art.

(456.) It has been supposed that the heart exerts some force in the diastole as well as systole; and that the recoil of the muscles when they spring back, after they have performed their contraction, creates a force of suction, which promotes the flow of blood in the great veins towards the heart. But the truth of this proposition is exceedingly dubious.

(457.) The movements of the heart are completely involuntary; that is, are entirely beyond the control of the will. Nor are its natural actions accompanied by any sensations. They are, generally speaking, totally independent of the nervous system; for they may be maintained after the destruction of the brain and spinal cord, and even after all the nerves which supply the heart have been divided. Yet these movements are capable of being influenced, often very suddenly, by an impression made upon any considerable portion of the nervous system. The regular contractions of the heart appear to be excited simply by the stimulus of distension from the periodical influx of blood into its cavities. This organ is evidently endowed with a very high degree, and a very peculiar kind of irritability, not subject, like that of the voluntary muscles, to exhaustion, by the most powerful exertions, reiterated for an indefinite time.

2. *Actions of the Arteries.*

Action of the arteries.

(458.) Whatever be the velocity with which the blood is projected from the heart into the aorta, that velocity is soon retarded, in the course of its progress from the larger to the smaller branches of that arterial trunk. This is amply illustrated by the observation of the effects which follow the division or wounds of arteries in different parts of their course. A wound of the carotid artery is almost instantly fatal, from the deluge of blood which rushes out from the opening. The division of the other large arterial trunks is no less certainly fatal, if means be not at hand to stop the torrent that gushes out with resistless impetuosity. In the smaller arteries, such as those in which the motion of the blood can be viewed with the microscope, the current is very languid and feeble. It is, in reality, however, much slower than it appears to be; for it should be recollected, that in viewing the magnified image of an object, its motion is magnified in the same proportion as its dimensions.

Retarding forces.

(459.) The cause of this continual retardation of the blood is to be traced in the structure of the arterial system itself. The velocity of a fluid passing through a tube of unequal diameter in different parts, must be inversely as the area of the tube at each respective point of its length; that is, inversely as the square of the diameter. Accordingly, if we suppose two cylinders of different diameters joined together, and that a fluid is passing from one end to the other, it must evidently move with less velocity in the wider than in the narrower part; for if it did not, it would leave behind it a vacant space. But a vacuum of this kind can never take place in the living body, in which, with whatever other properties they may be endowed, the fluids are still obedient to the laws of hydraulics. The arterial system consists of an assemblage of tubes, which, though they continually diminish in their diameter as they divide into branches, yet as the united area of the branches is always greater than that of the trunk out of which they arose, they constitute, when taken as a whole, a system of channels of continually increasing capacity, as we follow them from the heart to the extremities. The whole cavity through which the blood moves, may therefore be represented by a cone, having its apex at the heart, and its base at the termination of the minutest arterial ramifications. The beginning of the aorta is, in reality, the narrowest part of the whole channel, considered with reference to the united areas of the successive order of branches as they divide. The sum of all the areas of the minutest ramifications of the arteries existing in the body, comprising myriads of myriads of vessels, if they could be collected together, would form an area of immense extent. No wonder, therefore, that the motion of the blood, when it arrives at this part of the circulation, should be so prodigiously retarded as actual observation shews us that it is.

(460.) Notwithstanding this great difference in the velocity of the blood in different parts of its arterial circulation, it would appear from the experiments of Poiseuille, that the pressure exerted by the blood, as measured by the column of mercury it will support at different distances from the heart, is not very different.

Elastic power of arteries.

(461.) The arteries being always full of blood, and their coats distended by its presence, the elasticity of these coats is always exerted, and produces a constant pressure on the blood, independently of any force that may urge it forwards. The entry of a fresh quantity of blood forced into them by the action of the heart, produces a slight additional distention of their coats, and a consequent reaction of their elasticity. This reaction of the arteries in each interval of the heart's pulsation, tends much to equalize the motion of the blood; and has the effect also of propagating the impulse originally given to it by the heart very quickly to the remoter parts of the arterial system. The velocity with which this impulse is transmitted, is much greater than the actual motion of the blood, and partakes of the nature of a wave, which, as is well known, advances with incomparably greater rapidity than the progressive motion of the fluid itself. It is the impulse given to the sides of the artery by this wave, as it may be called, which constitutes the *pulse*, and which is more particulary rendered sensible on compressing the artery with the finger.

Their muscular action.

(462.) It has been a much disputed question, both here and on the continent, whether the arteries assist the circulation by exerting any contractile power of their own. The evidence in favour of their exerting such an action is very strong, and apparently irresistible. The power of the heart, however enormous we may suppose it to be, would appear to be quite inadequate to drive the whole mass of the blood through the infinite number of narrow and contorted channels through which it actually moves, were it not assisted by some additional force, derived from the contractions of the arteries themselves. Many facts prove that variations in the impetus of the blood, and in the quantity which circulates in particular parts, occur at different times, quite independently of any general alteration of the circulation, or of any corresponding change in the action of the heart. The only assignable cause for such differences is a variation in the extent of action of the arteries. Numerous experiments show that stimuli applied to the smaller arteries occasion in them a temporary constriction at the points where irritation has been excited; which, after a certain time, goes off spontaneously. Various other facts also prove that the arteries have a power of spontaneous contraction; this power is exhibited in the most unequivocal manner when an artery has been cut across; the consequent hæmorrhage being, after some time, stopped by this action of the coats of the artery. This contractile force of arteries is probably derived from muscularity, although the muscular structure is not distinctly perceptible. It is considerably greater in the smaller than in the larger arteries; and it is probably greatest of all in the capillaries.

(463.) Notwithstanding the facts above stated, the muscularity of the arteries is denied by some of the most eminent of the continental physiologists; and among others, Magendie, Broussais, Adelon, Alard, Rolando, and Müller.[1]

3. *Action of the Capillaries.*

Action of the capillaries.

(464.) The particular agents by which the circulation is carried on in the capillary vessels cannot be very precisely determined; and the subject has given rise to much controversy among physiologists. The action of these vessels is evidently of the greatest importance in relation to every other function, and more especially to the production of every permanent change which may take place in the form or composition of the organs. The variable state of the circulation in different organs at different times, must be occasioned principally by diversities in the actions of the capillaries. It appears from the experiments of Hunter, that while the larger arteries possess a greater proportion of elastic power, the smaller arteries have a comparatively greater muscular contractility; and this reasoning may, with great appearance of probability, be extended to the capillaries. It would appear, indeed, from various observations on the inferior animals, and in particular from those made by Dr. W. Philip, that the circulation in the capillaries may be kept up for some time after the pulsation of the heart has entirely ceased, and even when that organ has been altogether removed from the body. In many cases, indeed, the capillaries, when viewed with the microscope, have been seen to contract on the application to them of stimuli, which, in other cases, excite contractions in the muscular fibre. The pulsatory motion of the blood given to it in the arteries by the periodical contractions of the heart, is scarcely sensible in the smaller arteries, and is totally lost in the capillaries, where we find the blood moving in a uniform stream. This is a necessary consequence of the tortuous course of the channels through which it passes, and of the numerous communications among these vessels, which equalize the effects of the original impulse, and extend them over the whole period of time that intervenes between one pulsation and the next.

4. *Action of the Veins.*

Action o the veins Vis à ter

(465.) The blood which is returned from every part of the system by the veins, is gradually accelerated in its progress towards the heart, for a similar reason that it was retarded in its transmission through the arteries, namely, that the capacity of the channel through which this fluid is passing is continually diminishing; for the united area of the beginnings of the veins is incomparably smaller than the conjoined area of the two venæ cavæ. The office of the veins generally appears, on the whole, to partake more of a mechanical action than that of the arteries, though it is probable that the smaller veins may derive from their structure powers analogous to those of the capillaries. The power which impels the blood forwards in the veins is chiefly the impulse it has already received, and the pressure exerted on it from behind, or what has been technically termed the *vis à tergo*. This force is assisted also in many situations by the pressure made on the veins by the action of the neighbouring muscles, which, in consequence of the valves placed in the course of the veins, preventing all retrograde motion in the blood, must contribute to force it onwards towards the heart. It is probable, however, that the veins are not altogether destitute of a power of contraction, though less considerable than that possessed by the arteries; and that the exertion of this power has some share in accelerating the motion of the blood in the venous system. Whatever power may arise from the force of dilatation exerted by the auricles of the heart during their diastole, which, however, we have reason to believe is very trifling, must be added to the account of the forces that tend to promote the motion of the blood towards those cavities. Some have supposed that a similar power is derived from the expansion of the chest in the act of inspiration; but this, if it exist at all, is of very inconsiderable amount. The venæ cavæ near their termination in the auricles, are furnished with a distinct layer of muscular fibres, apparently for the purpose of enabling them to resist the retrograde impulse communicated to the blood by the contraction of the auricles.

5. *Pulmonary Circulation.*

Pulmona circulatio

(466.) There is nothing very different in the circulation through the pulmonary arteries, capillaries, and veins, from what takes place in the corresponding vessels of the systemic circulation, excepting that junctions are occasionally formed between the smaller branches of the branchial arteries which have their origin from the aorta, and the branches of the pulmonary artery. The phenomena which occur in asphyxia, or death from suffocation, prove that the pulmonary capillaries have a distinct action of their own in carrying on the circulation. The beautiful net-work formed by the inosculating branches of the pulmonary capillaries was first observed by Malpighi, and has received the name of *Rete mirabile Malpighi.* The pulmonary veins are wholly destitute of valves, not being exposed to variations of pressure from the actions of the surrounding muscles. They are furnished, like the venæ cavæ, with a reinforcement of muscular fibres, in the neighbourhood of the left auricle in which they terminate.

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[1] See Milligan's *Translation of Magendie*, and Bostock's *Physiology*, p. 244.

(467.) In one respect, the vessels of the pulmonary circulation differ from those of the systemic, namely, that the arteries are carrying dark-coloured blood, and the veins florid blood; the former being termed *venous*, from having the qualities of that which is returned by the veins of the system; the latter being termed *arterial*, because it has the qualities of that which circulates in the systemic arteries.

CHAP. VIII.—RESPIRATION.

bjects of spiration.

(468.) The object of the function of respiration is the conversion of venous into arterial blood, by its exposure to the chemical influence of atmospheric air received into the lungs. This arterialization of the blood is a process more essential to the continuance of life than even the assimilation of aliment. The necessity for air is more imperious than the demand for food; and the interruption to its supply cannot be continued for a few minutes without being fatal to life. In comparing the extent to which this function is carried on in the different classes of animals, we shall find that in general the intensity of all the vital actions is nearly in proportion to the perfection in which the objects of this function are accomplished.

(469.) The consideration of the function of respiration, then, comprises an inquiry into the three following objects; first, the mechanical means by which the air is alternately admitted and discharged from the lungs; secondly, the provision made for bringing the blood to the lungs, and exposing it to the action of the air; and, lastly, the chemical changes which are produced on the blood by the action of the air in that organ. The means of fulfilling the second of these objects has already been sufficiently explained in the account we have just given of the circulation. It remains, therefore, that we consider the first and third branches of the inquiry.

Sect. I.—*Mechanism of Respiration.*

chanism espira-

(470.) The anatomical structure of the organs of respiration, namely, the lungs with its air passages, including the trachea. bronchiæ, and air cells, together with the general conical cavity of the thorax, bounded by the sternum in front, the spine behind, and the ribs on every other side, while its lower side, or basis of the cone, is closed by the diaphragm, have already been fully detailed in the treatise on Anatomy, to which it is only necessary here to refer.

(471.) The mechanical act of respiration is divisible into two periods, that of *inspiration*, during which air is drawn into the lungs, so as to distend their vesicles, and *expiration*, during which the air which had been so received is expelled.

piration.

(472.) Inspiration is accomplished by enlarging the capacity of the thorax in all its dimensions. This is effected by the action of different sets of muscles. The principal muscle of inspiration is the diaphragm, which has an arched form, the convexity being towards the chest. Its attachments by radiating fibres arising from a central tendinous portion, and inserted into the ribs which form the lower margin of the chest, are such, that when they contract they draw down the middle tendon, and render the diaphragm more flat than it was before. Hence the space above is enlarged. The flattening of the diaphragm takes place chiefly in the fleshy lateral portions, but the middle tendon is also slightly depressed.

(473.) The second set of muscles employed in inspiration are those which elevate the ribs; and the principal of these are the two layers of intercostal muscles. Each rib is capable of a small degree of motion on the extremity by which it is articulated with the vertebræ. This motion is chiefly an upward and a downward motion. But since the ribs, as they advance from the spine towards the sternum, bend downwards in their course, the effect of the vertical motion just described will be that of raising the sternum, and increasing its distance from the spine; enlarging, consequently, the capacity of the chest. The intercostal muscles are disposed in two layers, each passing obliquely, but with opposite inclinations, from one rib to the adjacent rib. Hence they act with the advantage of oblique muscles on the principles formerly explained.

(474.) Thus there are two ways in which the chest may be dilated; first, by the diaphragm, and, secondly, by the muscles which elevate the ribs. In general, when the respiration is natural and unconstrained, we chiefly breathe by means of the diaphragm; but we also employ the intercostal muscles when the respiration is quickened or impeded by any cause. If respiration should be rendered difficult several other muscles are called into play in aid of the intercostals; namely, the great muscles situated in the back and sides, which connect the ribs to the spine and to the scapula; and several of the muscles of the neck are also thrown into action as auxiliaries on these occasions, when the respiration becomes laborious.

(475.) The glottis is kept open, during inspiration, by the muscles of the larynx which perform that office; and when a forcible inspiration is made, the nostrils are expanded, the lower jaw depressed, and every action which can in the remotest degree concur in the effect of removing all obstruction to the passage of the air into the trachea, is exerted.

(476.) Having thus shown how the cavity of the thorax is dilated, let us next trace the effect of this expansion upon the lungs. It is obvious, that if when, by the descent of the diaphragm and elevation of the ribs, the cavity of the chest is enlarged, the lungs were to remain in their original situation, an empty space would be left between them and the sides of the chest. But no vacuum can ever take place in the living body; the air already present in the air-cells of the lungs must, by its elasticity, expand these organs; and the external air, having access to them by means of the trachea, will rush in through that tube in order to restore the equilibrium. This, then, is *inspiration.*

Expiration.

(477.) The expulsion of the air from the lungs constitutes *expiration.* This takes place as soon as the air which had been inspired has lost a certain portion of its oxygen, and received in return a certain quantity of carbonic acid gas and of watery vapour, by having had communication with the blood in the pulmonary capillaries. When thus contaminated it excites an uneasy sensation in the chest, and the intercostal muscles relaxing, the ribs fall into their original situation, and the relaxed diaphragm is pushed upwards by the action of the abdominal muscles. The lungs, being compressed, expel the air they had received, and this air escapes through the trachea. The movements of inspiration are in like manner prompted by an uneasy sensation consequent upon the presence of venous blood in the pulmonary system.

(478.) Thus the lungs are merely passive agents in the mechanism of respiration; for it does not appear that they have, as was at one time supposed, any inherent power of extension or contraction, if we except only that arising from the elasticity which they possess in common with all membranous textures. Hence, if an opening be made in the sides of the chest, the lung on that side immediately collapses, in consequence of the internal pressure of the air against its air-cells, which kept the lung expanded, being balanced by the external pressure of the atmosphere which has been admitted on the outer surface of the lung.

(479.) The alternations of inspiration and expiration, which together constitute one act of breathing, take place, in ordinary health, about once for every four pulsations of the heart; and as both are generally accelerated in the same proportion, the same rule usually holds good in states of disease.

Quantity of air respired.

(480.) The quantity of air taken into the lungs at each inspiration has been very variously estimated by different experimentalists. It differs, indeed, considerably in different persons, and in different states of the system; but from the concurrent testimony of the most accurate experimentalists, the average quantity appears to be about forty cubic inches. By a forcible expiration there may be expelled, in addition to this quantity, about a hundred and seventy inches more. But even after this effort has been made, there still remain about a hundred and twenty cubic inches in the lungs; so that, adding all these quantities together, it will appear that the lungs are capable of containing, while in their most expanded state, after ordinary inspiration, about three hundred and thirty cubic inches of air. One eighth of the whole contents of the lungs, therefore, is changed at each respiration. If we suppose that we respire twenty times each minute, the quantity of air respired during twenty-four hours will amount to six hundred and sixty-six cubic feet.[1]

Sect. II.—*Chemical Effects of Respiration.*

Chemial effects. 1. On the air respired.

(481.) Before we inquire into the changes produced on the blood by its exposure to the air in the lungs, it will be proper to notice the changes which the air undergoes by this process. The air of the atmosphere is found by chemical analysis to consist of seventy-nine per cent of nitrogen, twenty of oxygen, and one of carbonic acid.[2] When expired, the principal change which has taken place in it is the substitution of a certain quantity, which, on an average, is about seven and a half per cent, of carbonic acid gas for a nearly equal quantity of oxygen gas, and the addition of a quantity of aqueous vapour. Air which has passed through the lungs only once is incapable of supporting the combustion of a taper, which is accordingly extinguished the moment it is immersed in the air. The weight of the oxygen consumed in the air respired in the course of a day, will be found to amount to about two pounds and a quarter avoirdupois, or nearly 15,500 grains, occupying in its gaseous state a volume of 45,000 cubic inches, or a little more than 26 cubic feet. The quantity of carbonic acid expelled from the lungs is somewhat less than this; its total bulk in the twenty-four hours amounting on an average only to 40,000 cubic inches, or 23·2 cubic feet. Its total weight is 18,600 grains, or 2·86 pounds avoirdupois. The weight of the quantity of carbon contained in this amount of carbonic acid is 5,208 grains, or very nearly three quarters of a pound; and that of the quantity of oxygen is 13,392 grains. Hence the quantity of oxygen which disappears from the air respired, over and above that which enters into the composition of the carbonic acid gas, is 2,108 grains, and had occupied, while in a gaseous state, 5000 cubic inches. The only way in which we account for the disappearance of this oxygen is, by supposing it to have been absorbed by the blood.

(482.) The numbers given above are, of course, to be taken as imperfect approximations to the truth, being deduced as the mean of the best authenticated observations, in which, however, there exist such great discrepancies as to render any accurate appreciations nearly hopeless. An excellent summary of the results which have been arrived at by different experimentalists, with critical remarks on their respective values, will be found in *Dr. Bostock's Elementary System of Physiology.*[3]

(483.) Much difference of opinion has prevailed with respect to the absorption or evolution of nitrogen during respiration. From the accurate experiments on this subject made by Dr. Edwards, it appears that on some occasions there is a small increase, and in others a diminution of the nitrogen of the air respired. But the limits within which we must confine ourselves in this treatise, forbid our entering into the experimental details from which this conclusion is deduced.

(484.) The quantity of water exhaled from the lungs in the course of a day, has been estimated by Dr. Thomson at nineteen ounces, and by Dr. Dalton at twenty-four.

(485.) It should be observed, however, that the quantity of carbonic acid thrown off from the lungs, is liable to great variation from several causes; it has been found by Dr. Prout to be greatest at noon, and least at midnight. It has also been ascertained that it is less in youth than in middle age; and that it is diminished by causes which induce fatigue or lessen the vital energies.

2. On blood.

(486.) We have next to inquire what changes have, in the meanwhile, been effected in the blood by the action of the air to which it has been subjected in the lungs. A visible alteration in the first place, is produced in its colour, which, from being of a dark purple, nearly approaching to black, when it arrives at the air cells by the pulmonary arteries, has acquired the bright intensely scarlet hue of arterial blood when brought back to the heart by the pulmonary veins. In other respects, however, its sensible qualities do not appear to have undergone any material change. Judging from the changes produced on the air which has been in contact with it, we are warranted in the inference that it has parted with a certain quantity of carbonic acid and of water, and that it has in return acquired a certain proportion of oxygen. Since it has been found that the quantity of oxygen absorbed, is greater than that which enters into the composition of the carbonic acid evolved, it is obvious that at least the excess of oxygen is directly absorbed by the blood; and this absorption, constitutes, no doubt, an essential part of its arterialization.

(487.) It has been much disputed whether the combination which seems to be effected between the oxygen of the air and the carbon furnished by the blood, occurs during the act of respiration, and takes place in the air cells of the lungs, or whether it takes place in the course of circulation. On the first hypothesis, the chemical process would be very analogous to the simple combustion of charcoal, which may be conceived to be contained in the venous blood in a free state, exceedingly divided and ready to combine with the oxygen of the air; and imparting to that venous blood its characteristic dark colour; while arterial blood, from which the carbon had been eliminated, would exhibit the red colour natural to blood. On the second hypothesis, we must suppose that the whole of the oxygen which disappears from the air respired, is absorbed by the blood in the pulmonary capillaries, and passes on with it into the systemic circulation. The blood becoming venous in the course of the circulation, by the different processes to which it is subjected for supplying the organs with the materials required in the exercise of their respective functions, the proportion of carbon which it contains is increased, both by the abstraction of the other elements, and by the addition of nutritive materials prepared by the organs of digestion. The oxygen which had been absorbed by the blood in the lungs, now combines with the redundant carbon, and forms with it either oxide of carbon, or carbonic acid, which is exhaled during a subsequent exposure to the air in the lungs. Many facts tend strongly to confirm our belief in the latter of these hypotheses.

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[1] See Bostock on *Respiration*, and also his *Physiology*, 3d edition, pages 321 and 361.

[2] The recent experiments of De Saussure tend to show that the proportional quantity of carbonic acid gas in atmospheric air is even less than this. He estimates it at only four parts by volume in a million volumes of air.

[3] We refer particularly to the 3d section of chap. vii. p. 336—362.

(488.) It appears from a multitude of experiments, as well as from observations of the phenomena which take place in asphyxia, (that is, in the suspension of the vital actions from an interruption to respiration, as in hanging or drowning, or immersion in any gas not fitted for respiration,) that if the blood be not arterialized, and if, retaining its venous character, it be circulated in that state through the arteries of the system, it will act as a poison to the organs to which it is sent, destroying both the nervous and sensorial powers, and impairing the irritability of the muscles; and that this is the cause of the rapidity with which death ensues under these circumstances. It thus appears that respiration requires to be constantly kept up in order to free the blood from the continual additions of carbon which are made to it by the various processes of assimilation and absorption. It is also a principal agent in perfecting the animalization of the chyle, which is added to the blood, and in converting it into fibrin.

SECT. III.—*Animal Temperature.*

volution heat.

(489.) Since we find that the human body, as well as those of all warm-blooded animals, is constantly maintained during life at a temperature higher than that of the surrounding medium, at least in temperate climates, it becomes interesting to inquire into the sources whence this heat is evolved. The union of carbon and oxygen which takes place in consequence of respiration, is the most obvious of these sources; and suggests that the evolution of animal heat takes place in a manner somewhat analogous to the ordinary combustion of carbonaceous fuel. The circumstance of the equable heat of every part of the body, excepting the immediate surface where it is cooled by the contact of the air, and by cutaneous perspiration, would be in perfect accordance with the theory of Dr. Crawford already explained; for if the combination of oxygen with carbon take place gradually in the course of the circulation, it will follow that the evolution of heat will also take place at the same time, and in the vessels employed in the circulation. Or even if the combination took place in the lungs, if it could be shewn, as Dr. Crawford endeavoured to prove, that arterial blood has a greater capacity for caloric than venous blood, all the heat that would have been evolved in the pulmonary vessels would be absorbed by the arterial blood, and given out in the course of its circulation, during its gradual conversion into venous blood, which has a less capacity for caloric.

(490.) It would appear, however, from some recent experiments of Dulong and Despretz,[1] that only three-fourths of the whole quantity of caloric produced by the living system can be explained by the combination of oxygen with carbon in respiration. Probably, therefore, several of the other chemical changes induced on the blood by the processes of secretion and nutrition, contribute to the further evolution of caloric, and to the maintenance of the animal temperature. This evolution appears, although primarily dependent on respiration, to be in a great measure controlled by the action of the nervous powers; and to be regulated by a variety of circumstances in the condition of the other functions, especially that of the circulation, which are very imperfectly known; and the inquiry into which would lead us into a field of discussion far too extensive for the limits within which we must confine ourselves in the present treatise. We must content ourselves, therefore, with again referring to the work of Dr. Bostock for more ample information on these subjects.

CHAP. IX.—SECRETION.

Object of secretion.

(491.) Secretion is that function by which various substances are either separated from the blood or formed from it, in order to be applied to some useful purpose in the economy. We have noticed, in the course of the preceding inquiries, several instances of fluids prepared from the blood, and rendered subservient to different uses in the economy. The saliva, the gastric and pancreatic juices, the bile, and the mucus lubricating the surface of the alimentary canal, are all examples of secretions subservient to digestion and assimilation.

(492.) Such being the general purpose answered by this function, we have first to examine the apparatus provided for its performance; secondly, the nature of the effects obtained; and, thirdly, the peculiar powers which are concerned in their production.

SECT. I.—*Apparatus for Secretion.*

Organs of secretion.

(493.) The apparatus employed by nature for the performance of secretion varies considerably in its structure, in different instances, according to the nature of the product which is to result from the operation; and according as that product is merely separated from the blood, in which it may already have existed, or is formed by the combination of certain elements and proximate principles furnished by that fluid. In the simplest cases, where that product is principally aqueous, and apparently consists of nothing more than the serous portion of the blood separated from it by mere transudation, we find no other organs requisite than those smooth membranous surfaces which we have already described under the name of the *serous membranes*. The mucous secretions proceed, in like manner, from the modified, yet still simple action of a membranous surface, of a rather more refined structure, namely, the *mucous membranes.* The more elaborate products of secretion, on the other hand, which are apparently formed by combinations of pre-existing elements, are obtained by the agency of organs of a more complicated structure, which are denominated *glands.*

SECT. II.—*Glandular Apparatus.*

Glands.

(494.) The essential part of the structure of a gland consists in a collection of tubes, more or less convoluted, united by cellular substance into masses of a rounded form, constituting a *lobule.* Each lobule has a separate investment of membrane; and the whole aggregate of lobules is furnished with a general membranous envelope, or capsule. In every gland we meet with a complex arrangement of numerous arteries, veins, nerves, and lymphatics, provided with ramified excretory ducts, which conduct away the secreted matter that has been prepared in the substance of the gland.

Conglobate glands.

(495.) The above description of a gland does not include those organs, which, although resembling the proper glands in their general appearance, perform no distinct office of secretion, and are therefore unprovided with any excretory duct. This is the case with those bodies belonging to the absorbent system, which bear improperly the title of *lymphatic* or *conglobate glands.* The spleen, the renal capsules, the pineal gland, the thyroid gland, and the thymus, are, in like manner, improperly included in the class of glands; for we have no evidence of their secreting any fluid, and indeed know nothing of their real functions.

Glandular system.

(496.) The catalogue of glands, strictly answering to the definition, will comprise the following organs, namely, the liver, pancreas, and kidneys; the salivary, lacrymal, and meibomian glands; the tonsils, the ceruminous glands of the ear, and the sebaceous glands of the face; the mammæ, the prostate, the testicle, Cowper's glands, the glandulæ odoriferæ, and the extensive system of mucous glands about the head and trunk. These parts, although differing widely from each other in many respects, agree in a sufficient number of particulars to allow of being classed together in one organic system, which Bichat has termed the *glandular system.*

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[1] See *Muller's Physiology*, by Baly, p. 83.

(497.) Most of the glands are arranged in pairs, as the kidneys, testicles, salivary and lacrymal glands, while others are single, as the liver and the pancreas.

Texture of glands.

(498.) The organization of the glandular system is exceedingly complex, and cannot be unravelled without great difficulty. The tissue of which they are composed presents us with no regular arrangement of fibres, such as we see in the muscles, ligaments, nerves, or bones; but the whole structure is made up of a congeries of vessels and cells, having no very firm cohesion amongst themselves, and hence admitting very readily of being separated by slight mechanical causes. While organs which have a more extensive fibrous organization possess considerable powers of resistance, a very moderate degree of violence is sufficient to tear asunder the texture of a gland. The resistance in the latter case is owing solely to the cohesion of the cellular tissue which connects their parts, and which differs in its density and strength in different glands.

Conglomerate glands.

(499.) There are three different ways in which the glandular tissue, or *parenchyma* of glands, as it has been generally termed, is disposed. In those glands which have been called *conglomerate,* a term which, as we have seen, has been used in contradistinction to the *conglobate,* or lymphatic glands, the organ is made up of distinct portions, connected together by a large quantity of loose cellular tissue, in the intervals of which the vessels and nerves are situated. These larger lobes are again made up of smaller lobes united in the same way. By successive divisions we obtain smaller and smaller component portions, till we arrive at last at very small bodies still visible to the naked eye, and which are called by anatomists *glandular acini.* These successive lobules are firmer in proportion as they are smaller, being surrounded and connected with the adjoining portions by shorter and denser cellular substance. The second, third, and even the fourth subdivisions of these lobes may easily be followed with the scalpel. The acini themselves are of a roundish figure and pale colour, and readily distinguishable from other parts by the absence of fibres. The microscope shows them, however, to be still farther divisible into smaller portions, between which are seen plates of cellular substance, and if we attempt to pursue these subdivisions with successively greater magnifying powers, we do not find that we can reach their limit. The above description is particularly applicable to the salivary, lacrymal and pancreatic glands.

Acini.

(500.) The second modification of glandular structure occurs in the liver and the kidneys, in which it is impossible to trace these successive divisions into lobules, after we have distinguished the primary lobes which they present. Their structure exhibits an uniform and even tissue, made up of glandular acini, closely united together into one substance. The connecting cellular substance, if any such exist, is very short and small in quantity; and hence these organs may be torn asunder with great ease, and their ruptured surfaces present the appearance of granulations.

(501.) The third description of glands applies to the prostate, to the tonsils, and in general to all the mucous glands.

Structure of glands.

(502.) On examining the course of the blood-vessels, the small arteries which enter into a gland are found to ramify in various ways through a mass of cellular texture. But it is a matter of great uncertainty what specific structure intervenes between the secreting arteries and the commencement of the excretory ducts. Two opinions have long divided anatomists on this subject. Malpighi, who was one of the first who investigated the minute anatomy of glands, asserted that the acini invariably contain a central cavity, or *follicle,* as it was termed, on the inner surface of which the arteries are distributed, while the secreted fluid is collected in the follicle, and conveyed away by the branch of the excretory duct which arises from the follicle. He considered the mucous glands of the alimentary canal, which undoubtedly present a structure of this kind, as the most simple forms of glandular structure; the larger glands being only aggregations of these simpler structures.

(503.) The theory of Ruysch, who also bestowed extraordinary care in the examination of glandular structures, is founded on the supposed continuity of the extremities of the arteries with the commencements of the excretory duct. This theory is so far opposed to that of Malpighi, that it pre-supposes all the glands to consist merely of an assemblage of vessels and of cellular substance, without any membranous cavities interposed between the arteries and excretory ducts. The opportunities of dissection which Ruysch enjoyed, and his unrivalled skill in the arts of injecting the vessels, and tracing their modes of distribution, gave great weight to his opinions, which seemed to be immediate deductions from what he saw, and had established as matters of fact. Fluids could be made by injection to pass very readily from the blood-vessels into the excretory ducts, both in the kidneys and liver. After these organs have been accurately injected, they may be resolved, by subsequent maceration, into small clusters of blood-vessels; what Malpighi had represented as hollow acini, seemed to be in reality composed of a congeries of these minute vessels. This appeal to the evidence of the senses, and the admirable preparations which supported it, brought over almost all the anatomists of that time to the opinion of Ruysch; and Boerhaave himself, who had been a zealous defender of the doctrine of Malpighi, and written in support of it, was at length induced to adopt the views of Ruysch.

(504.) This controversy was sustained for a great many years in the schools of medicine; and the opinions of anatomists continue even at the present time to be divided upon this subject. Probably both these opinions may in part be correct, as applied to different glands, though not universally true; and secretion may perhaps be in some cases performed by continuous vessels, and in others by an interposed parenchyma, of a cellular or more intricate organic apparatus.

(505.) As the structure of the secreting organs admits of great variety, it may be useful to advert to some of the terms by which these minute parts have been designated. The terms *acini, cotulæ, cryptæ, folliculi, glandulæ, lacunæ, loculi, utriculi,* have been almost promiscuously used; being, as Bell humorously observes, "so many names for bundles, bags, bottles, holes, and partitions." The term *acinus* has been already explained, (§ 499). *Cotulæ* are merely superficial hollows, from the surface of which the secretion is poured forth. A *crypta* is a soft body, consisting of vessels not completely surrounded with a membrane, but resolvable by boiling or maceration. *Follicles* are little bags appended to the extremity of the ducts, into which the secretion is made, and from which it is carried off by the ducts. *Lacunæ* are little sacs, opening largely into certain passages, and into which generally mucus is secreted.

Excretory ducts.

(506.) The *excretory ducts,* whatever may be their exact origin, consist at first of an infinite number of capillary tubes, which, like the veins, soon unite together into more considerable tubes. These generally pursue a straight course through the glandular tissue, unite with one another, and form at last one or more large tubes. The only exception to this general proposition occurs in the excretory ducts of the testicle, which pursue a singularly tortuous course before they unite into the vas deferens on each side.

(507.) There are three varieties in the mode of termination, with regard to the excretory ducts of glands. In the first case, the ducts unite into several distinct tubes, which open separately, and without any previous communication. Sometimes these separate apertures are met with in a more or less distinct prominence, as in the breasts, the prostate, and the sublingual glands. At other times, the orifices are found in a depression, or kind of cul-de-sac, as in the tonsils, and in the foramen cœcum of the tongue. In the second case, which includes the greater number of glands, their fluids are poured out by a single tube, having a simple orifice. In the third case, some glands deposit the produce of their secretion in a reservoir, where it is retained, in order to be expelled at particular times: as is exemplified in the kidneys, liver, and testicles. In this case there must be two excretory tubes; one to convey the secretion from the gland to the reservoir, and the other to transmit it to its final destination. The size of the excretory ducts will, of course, be regulated very much by their number: when several are produced from one gland, they are very small, and sometimes scarcely perceptible. Those which are single are longer with reference to the size of the gland, and generally pass for some distance, after quitting the gland. In the pancreas, however, this is not the case, the common duct being concealed in the substance of the gland.

(508.) Whatever the arrangement of the excretory ducts may be, they all pour their fluids, either on the surface of the body, or on the surface of some of the mucous membranes. In no instance do they terminate on serous or synovial surfaces, or in the common cellular membrane. All the excretory ducts are themselves, indeed, provided with an internal mucous membrane, which is a continuation of the cutaneous, or mucous surface on which they terminate. In addition to this they are furnished with an exterior coat, formed of a dense and compact membranous and fibrous substance. Every excretory duct may therefore be considered as made up of these two coats, namely the external one, which is membranous, and the internal one, which is mucous.

Th y of Mü r.

(509.) Among the latest theories relating to the structure of the organs of secretion, is that adopted by Müller,[1] who conceives that the glandular organization consists essentially of a modification of the excretory duct, the remote extremity of which, or that most distant from the discharging orifice, is closed; and the particles of which exhibit a fine net-work, or plexus of minute blood-vessels, whence the secretion is in the first place derived, and afterwards conveyed away by the duct, into the cavity of which it is poured. The duct itself may be variously divided and subdivided; and its trunk and ramifications may be variously contorted and convoluted in different cases, without, however, constituting any material difference in its essential structure.

SECT. III.—*Arrangement and Properties of the Secretions.*

Arr e- men f the secre ns.

(510.) The classification of the various secretions which are met with in the system has been attempted by different physiologists, but great difficulty has presented itself in fixing on a principle susceptible of being practically applied to substances of such different chemical and mechanical properties, as are those which are to be the subjects of this arrangement. Haller,[2] adopting for his basis their chemical qualities, distributed them under the four classes of aqueous, mucous, gelatinous, and oily. Fourcroy arranged them under eight heads; namely, the hydrogenated, the oxygenated, the carbonated, the azotated, the acid, the saline, the phosphated, and the mixed.[3] Richerand adopts the six classes of lacteous, aqueous, salivary, mucous, adipose and serous;[4] and Dr. Young those of aqueous, urinary, milky, albuminous, mucous, unctuous, and sebaceous.[5]

(511.) Dr. Bostock[6] distributes the secretions under the eight heads of the aqueous, the albuminous, the mucous, the gelatinous, the fibrinous, the oleaginous, the resinous, and the saline; an arrangement which, in a chemical point of view, is the clearest and most natural that has yet been devised. We shall briefly notice these several classes in the order above stated.

1. *The Aqueous Secretions.*

Aqueous secretions.

(512.) The aqueous secretions are those which consist almost entirely of water, and of which the properties depend principally on its watery part; any other ingredient it may contain being in too small a quantity to give it any specific characters. The two secretions which are referable to this class are the cutaneous perspiration, and the exhalation from the lungs.

(513.) With regard to the fluid of perspiration, it seems doubtful whether it contains any ingredients that are constantly present in it, or that are essential to its nature. It appears to differ, indeed, considerably in different individuals; and varies even in the same individual, according to the state of the system. Its analysis was attempted by Berthollet, and afterwards by Fourcroy; but the most complete examination into its properties is that of Thenard, who considers it to be essentially acid, and that acid to be the acetic. He found in it, also, an appreciable quantity of the muriates of soda and of potass, with traces of the earthy phosphates and of oxide of iron, together with a very minute quantity of animal matter. Berzelius, on the other hand, who has examined this fluid still more recently, finds the free acid to be the lactic, accompanied with the lactate of soda. An elaborate analysis of the fluid of perspiration in a person labouring under disease, has also been made by Dr. Bostock.[7] The aqueous exhalations from the lungs appears to be so perfectly similar to that from the skin, as not to require further notice.

2. *The Albuminous Secretions.*

Albuminous secretions.

(514.) The albuminous class of secretions are numerous, and comprehend both solid and fluid substances. We have already seen that all membranous and fibrous textures, but especially the latter, are composed principally of a material corresponding in its chemical properties to coagulated albumen, (See § 165). But there are many fluid secretions which contain large proportions of this ingredient in an uncoagulated, or liquid state; such as the secretion which exudes from serous membranes, and also occupies the interstices of the cellular texture, and which has been termed the *liquid of surfaces*, (See § 135). This fluid also contains, besides coagulable albumen, an animal matter similar to that which is found in the serosity of the blood, and a small quantity of the usual saline matters which enter into the composition of almost all animal products.

3. *Mucous Secretions.*

Mucous secretions.

(515.) The mucous secretions are characterised by the presence of a substance which does not pre-exist in the blood, but which is prepared by a proper secretory or glandular action. The properties of this substance, or *mucus*, have been already noticed, (§ 301). To the head of the mucous secretions, Dr. Bostock is inclined to refer also the saliva, the gastric and pancreatic juices, the tears, and the semen.

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[1] *De Glandularum Secernentium Structura*, &c. Lipsiæ, 1830.

[2] *Elementa Physiologiæ*, v. *b*. 2.

[3] *Systême des Conniss. Chym.* ix. 159.

[4] *Physiologie*, § 88, p. 235

[5] *Med. Lit.* p. 109.

[6] *Physiology*, p 480.

[7] *Medico Chirurgical Transactions*, xiv. 424.

4. *The Gelatinous Secretions.*

Gelatinous secretions.

(516.) The gelatinous secretions derive their essential character from the predominance of gelatin in their composition. This substance is found in great abundance in most of the solids, and particularly in the membranous structures. It is strictly a product of secretion; for it is not met with in the blood, and must therefore be formed by some chemical change in the elements of the blood, from which the materials for its preparation are derived. There is reason to believe, from the discovery of Mr. Hatchett of the possibility of converting albumen into gelatin by digestion in diluted nitric acid, during which the albumen combines with an additional quantity of oxygen, that some change analogous to this is effected in the living body during the process of its secretion. The characteristic properties of gelatin have already been noticed, (§ 279.)

5. *The Fibrinous Secretions.*

Fibrinous secretions.

(517.) The fibrinous secretions compose the fifth class, and are so named from their correspondence in chemical properties to the fibrin of the blood, which fibrin is probably the source from whence these secretions derive this ingredient. They constitute the organic products most completely animalized in their chemical constitution; and they at the same time retain, in their physical properties, the peculiar cohesive tendency and fibrous character of the substance from which they are produced. The muscular fibre is the principal, if not the only substance which comes under this head.

6. *The Oleaginous Secretions.*

Oleaginous secretions.

(518.) The oleaginous secretions derive their essential character from the presence of an oily ingredient. They compose a numerous and varied class, comprehending those in which the oil forms the greatest part of the substance, and those in which it is more or less mixed with a large proportion of other animal principles. The fat is the principal secretion included in the first division; a substance which, from its being extensively deposited in various parts of the body, must evidently be formed by some peculiar action of the capillary system of vessels. As it consists almost wholly of hydrogen and carbon, we must conclude that its formation is effected by the exclusion of nitrogen and oxygen from the proximate elements of the blood, and the consequent intimate combinations of their carbon and hydrogen. It is well known that the formation of fat, by whatever chemical operation it may be effected, often proceeds with great rapidity, whenever circumstances favour its production. The marrow, as was formerly observed, belongs also to this class of secretions. Dr. Bostock is disposed to refer to the same head the substance termed *cholesterine*, which forms the basis of biliary calculi.

Milk.

(519.) Milk is a secretion owing its principal characters to the oil which it contains, and which is combined with albumen, so as to form a kind of natural emulsion. When collected in a separate mass, it forms the well-known substance termed *butter*. The oily particles are, however, in the original state of milk, merely diffused by mechanical mixture throughout the watery fluid, as is evident from the appearance of milk under the microscope, when it exhibits a multitude of extremely minute globules, swimming in a transparent liquor. The size of these globules has been variously estimated by different observers, and indeed appears to be by no means uniform, varying in different instances from the 10,000th to the 5000th of an inch in diameter. These oily globules have a tendency to adhere together when the milk is allowed to rest, and in the course of a few hours collect at the surface in the form of cream, and by further coalescence they compose *butter*. The albumen may be obtained from the remaining fluid by the ordinary means of coagulation, and constitutes curd, which, as is well known, is the basis of *cheese*. The clarified liquor which remains, yields, by evaporation, a saccharine substance capable of being crystallized, and which is known under the name of *sugar of milk*. It differs from common sugar by being less soluble in water, and by its total insolubility in alcohol. Milk contains, besides these ingredients, several saline substances, as the muriate and sulphate of potass, the phosphates of lime and of iron, and also a peculiar animal matter, which yields a precipitate with infusion of galls. Milk is found to differ from the blood, and from most of the animal fluids, by the base of its salts being potass instead of soda. A peculiar acid, called the *lactic*, is formed by the fermentation of milk, and even alcohol may be obtained during this process. By the action of nitric acid on the lactic acid, a new acid is produced, termed the *saccholactic* or *mucic acid*, which unites readily with alkaline or earthy bases, and forms a peculiar class of salts.

Cerebra substance

(520.) The substance of the brain bears a considerable analogy to the oleaginous secretions, more especially to that of milk; for it consists of albumen intimately combined with a peculiar oily ingredient. Rather more than one-fourth of its solid substance consists, according to Vauquelin,[1] of a fatty substance, and nearly one-third of albumen; the remainder being composed of osmazome, phosphorus, acids, salts, and sulphur.

7. *The Resinous Secretions.*

Resinou secretio

(521.) The resinous secretions, which compose the seventh class, derive their specific characters from an ingredient which is soluble in alcohol, and is analogous to resin. Of these the most remarkable is the substance which constitutes the basis, or specific ingredient, of bile. (See § 366.)

Circulat in the liv

(522.) In connexion with the process of secretion which takes place in the liver, we have here to notice the remarkable peculiarity which occurs in the mode in which the blood is circulated through that organ. The liver is supplied, like the other organs, with arterial blood, by the hepatic arteries, which are branches from the aorta. But it likewise receives a still larger quantity of venous blood, which is distributed through its substance by a separate set of vessels derived from the venous system. The veins which collect the blood that has circulated in the usual manner through the abdominal viscera unite together into a large trunk, termed the *vena portæ*; and this vein, on entering the liver, ramifies like an artery, and ultimately terminates in the branches of the hepatic veins, which transmit the blood in the ordinary course of circulation to the venæ cavæ.

(523.) This complex arrangement of the vessels which compose the hepatic system has lately been unravelled with singular felicity by Mr. Kiernan, who in a paper contained in the *Philosophical Transactions*, gives an account of his valuable discoveries, of which we shall present the following abstract. The hepatic veins, together with the lobules which surround them, resemble in their arrangement the branches and leaves of a tree, the substance of the lobules being disposed around the minute branches of the veins like the parenchyma of a leaf around its fibres. The hepatic veins may be divided into two classes, namely, those contained in the lobules, and those contained in canals formed by the lobules. The first class is composed of interlobular branches, one of which occupies the centre of each lobule, and receives the blood from a plexus formed in the lobule by the portal vein; and the second class of hepatic veins is composed of all those vessels contained in canals formed by the lobules, and including numerous small branches, as well as the large trunks terminating in the inferior cava. The external surface of every lobule is covered by an expansion of Glisson's capsule, by which it is connected to, as well as separated from, the contiguous lobules, and in which branches of the hepatic duct, portal veins, and hepatic artery, ramify. The ultimate branches of the hepatic artery terminate in the branches of the portal vein, where the blood they respectively contain is mixed together, and from which mixed blood the bile is secreted by the lobules, and conveyed away by the hepatic ducts which accompany the portal veins in their principal ramifications. The remaining blood is returned to the heart by the hepatic veins, the beginnings of which occupy the centre of each lobule, and when collected into trunks, pour their contents into the inferior cava. Hence the blood which has circulated through the liver, and has thereby lost its arterial character, is, in common with that which is returning from the other abdominal viscera, poured into the vena portæ, and contributes its share in furnishing materials for the biliary secretion.

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[1] *Annales de Chimie*, lxxxi. p. 37.

(524.) The general conclusion which Mr. Kiernan draws from his anatomical researches is, that the hepatic artery is destined solely for the nutrition of the liver, and has no direct connexions, except with the branches of the vena portæ, after its own blood has become venalized.

rea.

(525.) Urea is another substance of a resinous nature, which may be ranked among the secretions, and which constitutes the peculiar or specific ingredient in urine. It is remarkable for containing a very large proportion of nitrogen, which is by this channel discharged from the system. This substance has been found in the blood of animals from whom the kidneys had been removed.

smazome.
erumen.

(526.) The peculiar proximate animal principle, termed by Thenard *osmazome*, is referred by Dr. Bostock to the class of resinous secretions. It was procured originally from the muscular fibre, of which it forms one of the component parts; and it appears to be the ingredient in which the peculiar flavour and odour of the flesh of animals principally depends. It is found, however, in most of the component parts of the body, as well solids as fluids. The *cerumen*, or ear-wax, appears also from the analysis of Vauquelin, to have a relation to the resinous secretions.

8. *The Saline Secretions.*

ine se-
tions.

(527.) This class comprehends all those fluids in which saline ingredients predominate; they are very numerous, are dispersed over every part of the system, and are more or less mixed with its constituents. They consist of acids, alkalies, and neutral and earthy salts. The following are the acids entering into the composition of animal substances, and which are, for the most part, united with alkaline or earthy bases; namely, the phosphoric, muriatic, sulphuric, fluoric, lithic, lactic, benzoic, carbonic, and oxalic acids; and perhaps also the rosacic and the amniotic. Soda, potass, and ammonia, are found in almost all animal fluids; but only the first of these is met with in an uncombined state. Of the earths, lime is by far the most abundant; magnesia is found in small quantity, and also silex.

(428.) With reference to their saline qualities, Dr. Bostock proposes a division of the secretions into four classes. 1. Those which are nearly without any admixture of salts. 2. Those which possess a definite quantity of salts, and these salts different from those which exist in the blood. 3. Those containing salts similar both in their nature and quantity to those of the blood. And, 4. Such as contain salts different from those in the blood, and which are also variable in quantity. The fat, the saliva, the liquor of surfaces, and the urine, may be given as examples of each of these divisions.

SECT. IV.—*Theory of Secretion.*

eory of
etion.

(529.) The nature of the powers and processes by which the products of secretion are prepared, is a subject involved in the greatest obscurity. There is scarcely any question in physiology, indeed, the investigation of which presents greater difficulties. At the very outset of the inquiry we are embarrassed by the very imperfect state in which the science of organized chemistry still remains; and it follows as a necessary consequence, that the precise nature of the chemical changes effected during secretion cannot be properly understood. That the operations themselves are of a chemical nature, must be inferred from their results, consisting of substances which differ in most instances very considerably from the constituents of the blood, whence their elements are obtained. The blood is evidently the great reservoir of nutriment, and the fountain whence all the materials of the secretions are derived. In a few instances, as we have seen, the process of secretion appears to consist simply of the separation of some of the proximate principles of the blood. The operation is, in that case, more of a mechanical than of a chemical nature, and is analogous to mere transudation or filtration, subject, however, to a certain power of selection exercised by the secreting organ. In the greater number of instances, however, the product of secretion appears to be a new formation, differing entirely from any of the proximate principles contained in the blood, and resulting therefore from a new combination of its elements.

(530.) Scarcely any light has been thrown on this mysterious subject by the anatomical investigation of the organs of secretion. Their intimate structure is generally so minute and complicated, as to elude the severest scrutiny of the anatomist, even when assisted by the best optical instruments. What increases the difficulty of finding any clue to the labyrinth, is, that we often see parts having apparently very different structures giving rise to secretions which are nearly identical in their qualities; and conversely, we see substances having very different properties produced by organs very closely resembling each other in their structure.

(531.) Sometimes we find no distinct secretory apparatus, the whole process appearing to be conducted in the capillary vessels, out of the sides of which the product seems to transude. In other instances, the secreted fluid exudes from the smooth surface of a membrane, as is the case with the serous secretions in all the closed cavities of the body, such as those of the peritoneum, pleura, pericardium, and pia mater. The matter of perspiration finds its way through the skin and cuticle without any visible ducts or even pores, appearing simply to transude through the bibulous substance of the latter.

(532.) In other cases we find the secreting membrane furnished with minute processes, or *villi*, from the extended surface of which the secretion is produced. At other times, there are *follicles*, or *crypts*, as they are called, into which the secreted fluid is poured, and where it is collected previously to its discharge by its appropriate channels. These minute cavities are occasionally grouped together, and covered with a denser investing membrane common to the whole assemblage, constituting the masses which are called *glands*. But no practical advantage has arisen from the technical or anatomical classification of glands, neither has any information of value been gathered from the examination of the mode in which the blood-vessels are distributed in those organs; although this mode of distribution is apparently very different in different cases, each seeming to be intended for the application of some definite but unknown principle of action. Being wholly in the dark with regard to the specific objects intended to be answered, we can form no rational conjecture as to the designs of nature in the contrivances she has adopted. We see, in some instances, the smaller arteries divide suddenly, as soon as they have reached the gland, into very numerous minuter branches, like the fibres of a hair pencil. This has been called the *pencillated structure*. The arrangement in other cases is somewhat different, though similar in its principle; the minuter branches spreading out from their origin, like rays from a centre, and forming a *stellated structure*. Sometimes we observe the arteries of the secreting organ much twisted and contracted in their course, and collected into spiral coils, before they terminate. All the varieties of secreting organs, as Mr. Mayo observes, appear to be only contrivances for conveniently packing a large extent of vascular surface into a small compass. So intricate, indeed, are those complex arrangements, that it is impossible to attempt to unravel them with any prospect of success. In a word, nothing hitherto known relative to the structure of glands has explained the mode in which they act, or has thrown any light upon the nature of the substances they produce.

Hypothesis of fermentation. Of organic filtration.

(533.) In this, as in other subjects, where facts are wanting for its elucidation, we find numberless hypotheses proposed in their stead. Secretion was formerly pronounced to be a species of fermentation, by those who could attach no definite idea to the term they employed. Others sought to explain secretion by various mechanical hypotheses, supposing it to be the result of a mere organic filtration of particles already existing in the blood; they racked their imaginations for the invention of forms of apertures and channels capable of admitting particles having corresponding figures, and of refusing a passage to the rest. Leibnitz compared the glands to filters, of which the pores were originally impregnated with a particular fluid, which fluid would therefore be allowed to pass, to the exclusion of all other fluids, in the same manner as a paper impregnated with oil prevents the passage of water, but allows oil to be transmitted. This unchemical theory proceeded on the hypothesis that all the secreted matters pre-exist ready formed in the blood, and require only to be separated by the glands; a supposition of which the later improvements in animal chemistry have sufficiently exposed the falsehood.

(534.) But even admitting the operation of the secretory organs to be wholly of a chemical nature, we are still completely in the dark as to the means which nature employs in the hidden laboratories of organization; nor do they appear in any way reconcileable to the ordinary laws of chemical affinities to which inorganic substances are obedient. The means employed are superior to mere chemical agency, in the same degree as the operations of chemical affinities transcend those of mechanism. All that we can conceive to be the office of the different series of vessels, which, by ramifying into smaller and smaller tubes, have the effect of subdividing the blood, as by a strainer, to certain degrees of tenuity, is that merely of preparing it for the changes it is to undergo in that stage of the process in which the essential conversion consists. Farther than this we cannot venture to speculate, knowing, as we do, so imperfectly either the changes produced, or the means by which these changes can be effected; unless, indeed, we endeavour to call to our assistance the power of galvanism, which has been, in modern times, proved to be so important and powerful an agent in effecting changes of chemical composition. But the analogy is yet too vague to serve as the basis of any solid theory.

Influence of the nerves.

(535.) There is no doubt that in many cases the process of secretion is considerably influenced by the condition of the nervous powers. Thus the section of the par vagum is invariably followed by the diminution or total suppression of the gastric juice, and by the increase of the secretion of bronchial mucus. Under these circumstances, the secretions of the stomach are restored by directing a stream of galvanic electricity through the nerves that have been divided; a fact which is explicable only in one of two ways, namely, either by supposing that the galvanic influence is the same as the influence derived from the nerves, or that galvanism excites a fresh exertion of the nervous influence, in the portion of the nerve on which its action is directed.

Organic affinities.

(536.) On the whole, as it appears impossible to refer the phenomena of secretion to any of the other known laws of matter, whether chemical or mechanical, it becomes us to acknowledge our ignorance of the real causes that produce them, and to ascribe them to the agency of those powers to which we have given the name of the *organic affinities;* by which term, however, we are far from wishing to imply that these affinities essentially differ in their kind from the ordinary chemical affinities which regulate the combinations of the same elements in unorganized bodies; but only that their operation is modified by the peculiarity of the circumstances in which they are placed. One of the principal causes of this peculiarity appears to be the influence of the *nervous power;* a power carefully to be distinguished from the sensorial powers, hereafter to be considered, and wholly of a physical character, exercised by the nervous system, and controlling the actions of the blood-vessels, and more especially of the capillaries, and also those chemical changes which produce the evolution of animal heat, regulating in a particular manner the processes of secretion, and in some instances producing the contractions of the muscles in a way directed to some beneficial purpose, and in cases where the interference of the mind does not take place. But of this latter exercise of the nervous power we shall have to speak more at large when we come to treat of the involuntary motions.

Nervous power.

CHAP. X.—ABSORPTION.

Objects absorption.

(537.) The objects of the function of absorption are, first, the removal of those materials which have become unserviceable and noxious from the situations where their presence is injurious; and, secondly, their transmission into the general mass of circulating fluids. The lymphatic vessels are appropriated to this office, and form, with the lacteals, which perform a similar service with respect to the chyle, one extensive system of vessels denominated the *absorbents*.

SECT. I.—*Structure of the Absorbent System.*

Lacteals and lymphatics.

(538.) The absorbent system, then, is understood to comprehend two sets of vessels, distinguished only by a certain difference in the office which they perform, but agreeing in their structure and general functions. The first are the *lacteals*, which, as we have seen, are appropriated to the conveyance of the chyle, or nutritious fluid prepared in the intestines, into the general reservoir of nutriment, the sanguiferous system. The second are the *lymphatics*, which perform a similar office with regard to the materials of the body itself, that have become either useless or noxious, or with respect to foreign substances applied to the external surface, or introduced into any part of the body. The same general description, as to structure, will apply to both these systems of vessels.

Distribution of th lymphati

(539.) Absorbent vessels are met with in almost every part of the body. They may be regarded as analogous, or even supplementary in their office, to the veins; and accordingly, their structure and mode of distribution are very similar to that portion of the sanguiferous system. The absorbents arise from the various surfaces of the body, external as well as internal, by very minute branches; but whether these branches commence by open orifices, or imbibe the fluids they receive through the medium of their coats, we have hitherto no certain knowledge. The lesser branches of the lymphatics, like those of the veins, join together to form larger branches; while these again successively unite into larger and larger trunks, till they conduct their contents into the veins, into which they open. They communicate with one another freely in their course; and these connexions are frequently so numerous and intricate, as to form an extensive net-work, or plexus of lymphatic vessels. They are furnished with numerous valves, which, like those of the veins, are of a semilunar or parabolic form, disposed in pairs, and placed so as to prevent any retrograde motion of the contents of the vessels.

eir ts.

(540.) Like the veins, the absorbents have thin and transparent coats, which are possessed of considerable strength, so as to admit of being distended much beyond their natural size without being ruptured, by injected fluids urged into them with considerable force. When they are thus enlarged by injection, they resemble a string of beads; an appearance arising from the numerous valves they contain, and which occur at short, but generally unequal intervals.

(541.) The absorbent vessels are formed of two coats, which in the principal trunks are very distinct from each other. The external coat is the one which constitutes the chief bulk of the vessel, and gives it its general form. It is of a membranous structure, and is connected with the surrounding parts by a loose tissue of cellular substance. It exhibits, where it joins the inner coat, more or less of a fibrous structure; and some anatomists have pretended even to have perceived traces of muscular fibres at this part. The interior membrane which lines the former, is more thin and delicate; and it is by duplicatures of this membrane that the valves are formed. These valves are remarkable for their strength, not being ruptured without the greatest difficulty.

mphatic nds.

(542.) The continuity of the course of the absorbents is interrupted in a variety of places, by small rounded bodies, which have been called *lymphatic* or *conglobate* glands, and which are situated on the track both of the lacteals and lymphatics. They seem to have a similar relation to the absorbents which the ganglia have to the nerves; and they have, on that account, been sometimes called the *lymphatic ganlia.* They are of various sizes; the smaller being placed near the origin, and the larger on the more considcrable trunks of these vessels. Those of greatest magnitude are situated at the root of the mesentery, in the course of the lacteals, and are denominated the *mesenteric glands.* These glands are sometimes detached, and sometimes in groups or clusters, and generally of an oblong rounded shape, and somewhat flattened, bearing some general resemblance to an almond. Their colour is a whitish red, of more or less intensity, according as they are situated more externally. Those of the mesentery are nearly white; those of the spleen brown; and those belonging to the lungs are of a very dark, or almost black hue. Each gland is enveloped in a thin, fibrous, and very vascular membrane, surrounded with dense cellular tissue, which sends down processes into the substance of the gland, dividing it into numerous compartments.

a rentia.

(543.) It would appear from the extensive researches of Mascagni, that every absorbent vessel, during its course, passes through one or more of these glands. Previous to their penetrating into the gland, each absorbent trunk branches out suddenly into numerous subdivisions, distinguished by the name of *vasa inferentia.* These vessels are distributed on the surface of the gland in a radiating form, so as to surround it with a kind of net-work. After they have entered the gland, their course becomes extremely difficult to unravel, from their numerous and minute ramifications, their tortuous course, and their frequent communications. It would appear, however, that while some acquire and retain an extreme degree of tenuity, others become dilated, and form cells, somewhat resembling the erectile tissue formerly described. That portion of the vessels which is destined again to collect the fluid, and conduct it forwards on its course, appears to have a similar structure, presenting a congeries of minute ramifications, and of dilatations or cells.

a entia.

(544.) By the successive reunion of these branches, they are all collected into a certain number of trunks which emerge from the gland, under the name of the *vasa efferentia.* The total capacity of the vasa efferentia is, in general, less than that of the vasa inferentia. Large clusters of lymphatic glands exist in the neck, the groin, the axilla, as well as in the course of the greater trunks, not far from their termination in the thoracic duct.

Thoracic duct.

(545.) The great trunks of the lymphatics occupy two principal situations; the one near the surface, and the other more deeply seated; and for the most part they follow the course of the veins. The main branches are finally reduced to three or four great trunks, which terminate for the most part in the thoracic duct. This is a vessel of considerable size, passing upwards close to the spine, in a somewhat tortuous course, to about half an inch above the trunk of the left subclavian vein. It then bends downwards, and opens into that vein, nearly at its junction with the jugular vein. Another similar, but shorter trunk, is found on the opposite side, which pours its contents into the right subclavian vein.

Lymph.

(546.) The nature of the lymph, or fluid contained in the lymphatic vessels, is but imperfectly known, in consequence of the difficulty of collecting it in sufficient quantity for examination. When viewed under the microscope it is seen to contain a number of colourless globules, much smaller and less numerous than the red particles of the blood.[1] Mr. Brande separated a small quantity of albumen from it by the application of voltaic electricity: he found that it also contained some muriate of soda. Berzelius states that the lactates are likewise present in it, derived, as he supposes, from the decomposed substance of different parts of the body, which is taken up by the absorbents. Reuss, Emmert, and Lassaigne obtained fibrin from the lymph of the horse, and Nasse and Müller[2] obtained some also from human lymph. When removed from the body, this fluid fibrin coagulates in less than ten minutes. Besides the above ingredients, Tiedemann and Gmelin state that the lymph contains salivary matter, osmazome, carbonates, sulphates, muriates, and acetates of soda and potass, with phosphate of potass.

SECT. II.—*Function of the Absorbents.*

Office of the lymphatics.

(547.) While the office of the lacteals is confined to the absorption of a particular kind of fluid, namely, the chyle, the power of the lymphatics extends to the removal of every species of matter which enters into the composition of the body, as occasion may require, as also various extraneous substances that may happen to be placed in contact with their mouths. Whether the lymphatics have the power of taking up solid materials of the body without their being previously liquified, is a point which is yet far from being determined. We are certain that the hardest and densest structures, such as the bones, are liable to absorption, in various instances, not only during the natural processes of their formation and growth, but also on occasions when they are subjected to extraneous pressure. We find that the bones are modelled by the pressure even of soft living parts, during their natural growth, or morbid enlargement. The rapid disappearance of the red tinge which the use of madder in the food had communicated to the bones, when that food is discontinued, has been supposed to warrant the conclusion that the particles of bones are at all times undergoing a quick periodical renovation. But it appears from more recent inquiries, that this inference has been too hastily drawn: the change of colour being the result of the disappearance of the colouring particles of the madder only, without its being at all necessary to suppose that the earthy particles of the bone are themselves changed, or successively absorbed and deposited along with the madder.[3]

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[1] *Müller's Elements of Physiology*, by Baly, p. 258.

[2] Ibid. p. 259.

[3] See a paper on this subject by Mr. Gibson, in the *Memoirs of the Literary and Philosophical Society of Manchester.* Second series, i. 146

Powers of absorption.

(548.) The nature of the process by which the particles to be absorbed are prepared for being taken up by the lymphatics;—the mode in which they are conveyed to the orifices of these vessels, if indeed they take their rise like the lacteals, by open orifices;—and the power by which they find their way into these vessels, and are conveyed onwards to their termination in the thoracic duct, are all subjects involved in the greatest obscurity. Capillary attraction is the only power to which the rise of the lymph in the lymphatic vessels appears to bear any near resemblance; but the analogy is far too vague and remote to be of much assistance to us in the solution of the difficulty. How far the powers recently discovered, and which have been termed *endosmose* and *exosmose*, whereby membranous substances allow the transmission in a certain direction, of particular fluids only, to the exclusion of others, are concerned in the phenomena, remains a subject for future investigation. It seems likely, however, to throw some light on the processes both of secretion and absorption; and perhaps may furnish an explanation of the selection evinced by the lymphatics in absorbing certain materials in preference to others. Absorption takes place with great facility from the mucous surfaces, and also from those formed by ulceration. It also takes place from the surface of serous membranes, though with less activity. From the external surface of the skin, absorption takes place with great difficulty, and only under particular circumstances, as when substances are forcibly pressed through the cuticle. Considerable absorption often occurs from the interior of the pulmonary air-cells. Absorption from the surface of the body is diminished, or even suspended, by greatly diminishing the pressure of the atmosphere on the part, as by the application of a cupping-glass.

Sect. III.—*Venous Absorption.*

Venous absorption.

(549.) Soon after the discovery of the lymphatic absorbents, a keen controversy arose as to whether absorption was performed exclusively by these vessels: for it was contended by many that the veins assisted in this process, and occasionally acted as absorbing vessels. The arguments and reasonings of Hunter and Monro, founded on numerous experiments, appeared to have completely decided the question, and established the exclusive agency of the lymphatics in the performance of this function. Of late years, however, the ancient opinion has been revived by Magendie and others, who seem to have satisfactorily proved that absorption is occasionally carried on by the veins themselves; and that many of the lesser lymphatic vessels terminate in the small veins, instead of proceeding to the thoracic duct. It has been ascertained, for instance, that where the great lymphatic trunks are tied in animals, substances injected into the stomach quickly find their way into the general mass of circulating blood, and may be detected in the urine. Poison introduced into a portion of intestine, completely isolated from the rest of the body, with the exception only of the artery and the vein, produces its effect upon the system nearly in the same time as if the natural connexions had been preserved. The same result takes place when a limb is separated from the body, by dividing every part excepting the artery and the vein, and the poison is introduced under the skin. It proves fatal in the usual time, although the only medium through which its influence can be supposed to be transmitted is the circulating blood, which must therefore, it is concluded, have received the poison by venous absorption.

(550.) The subject of venous absorption, and of the connexion between the lymphatic and sanguiferous systems, has of late years much occupied the attention of physiologists. Great labour has been bestowed on its investigation by Fohmann, Lauth, and Panizza, on the continent; and recently in this country by Dr. Hodgkin, who was appointed, with others, to form a committee for conducting this inquiry, by the British Association for the advancement of science. A short provisional report by this gentleman is published in the report of the sixth meeting of that association, in vol. v. p. 289, to which we must refer our readers, as containing the latest information on this important branch of physiology. Many facts render it exceedingly probable that the contents, both of the lacteals and of the lymphatics, are intermixed with that of the veins in the lymphatic glands.

Sect. IV.—*Effects of Absorption.*

Effects absorpti

(551.) The absorbents have a powerful influence in modifying the fluid secretions, as well as the solid materials of the body. Their agency in assisting the arteries and capillaries which effect the growth and nutrition of the body is beautifully exemplified in the processes of ossification and of dentition, where the changes can more easily be followed than in the progressive modifications of softer organs. All these facts lead to the conclusion that the absorbent vessels possess very extensive powers in modelling the organization of the body in all its parts. In the progress of life, various changes are effected in the size and form of different parts, either in the natural course, or from the effects of disease. We see various organs diminish in size, sometimes with great rapidity, from the general absorption of their substance, or, as it has been termed, from *interstitial absorption;* and in other instances from causes external to the organ affected, such as pressure or ulceration; in which cases the process is denominated *progressive absorption.* In some structures, especially those which are but scantily furnished with vessels, the renewal of particles is much slower than in more vascular parts; but even these are in a certain degree subject to a constant absorption and renewal of their particles.

Sect. V.—*Function of the Lymphatic Glands.*

Office o the lymphatic glands.

(552.) Of the offices performed by the lymphatic glands, which are so numerously interspersed in the course of the vessels, we are still in profound ignorance; an ignorance which is little to be wondered at, when it is considered that we are but imperfectly acquainted with their structure, and the course which the branches of the absorbents take in the interior of those bodies, and that we are also very much in the dark with regard to the nature of glandular action, and of the changes which it induces on the fluids subjected to its influence. These glands may either be proper secreting organs, intended to prepare a peculiar substance, which is to be mixed with the chyle and lymph, in order to assimilate them more and more to the nature of the blood with which they are to be united; or they may, by their tortuous passages, offer a mechanical obstruction to the progress of these fluids, and thus occasion in them spontaneous changes in the arrangement of their constituent parts. This latter view of the uses of the glands was taken by Mascagni, and he endeavoured to confirm it by pointing out differences in the nature of the lymph before and after it had passed through a gland; but this fact, if established, would be equally explicable on either hypothesis. The greater size and vascularity of these glands in youth, when the growth of the organs is most rapid, would lead to the belief that their functions are of importance in the elaboration of nutritive matter to meet the greater demand for the materials of growth at that period of life.

CHAP. XI.—EXCRETION.

Excreti

(553.) The expulsion from the system of those materials which are useless or noxious, is the office of *excretion;* and the organs or channels by which it is performed are called the *excretory organs.* They consist of the lungs, the skin, the kidneys, and probably also the liver.

Sect. I.—*Excretory Function of the Lungs.*

By the ngs.

(554.) Of the office of the lungs in purifying the blood from its redundant carbonaceous matter, we have already fully treated. Besides carbon, or rather carbonic acid, a large quantity of water is also exhaled by means of the lungs. As, however, there is reason to believe that considerable absorption of water also takes place from the same surface, the amount of loss sustained by the united operation of these two functions is only the excess of the exhalation over the absorption.

Sect. II.—*Excretory Function of the Skin.*

By the in.

(555.) We have already given the results of the chemical analysis of the matter of perspiration, in our account of the aqueous secretions, (§ 514). The chief ingredient is unquestionably water; and the average amount of water which escapes from the body through the channel of the skin, has been very variously estimated by different physiologists; for, indeed, it is hardly possible to arrive at any definite conclusion on this subject, from the great variations that occur even in the same individual at different times, especially according to the variable states of atmospheric temperature and humidity, and also according to differences in the activity of the circulation. The only satisfactory information we can hope to attain is, as to the aggregate loss by exhalation from the skin and the lungs. The daily loss of weight from these two sources taken together is stated by Haller[1] to vary from thirty ounces in the colder climates of Europe, to sixty in the warmer, and is estimated by Lavoisier and Seguin[2] at forty-five ounces in the climate of Paris. But this quantity is, of course, from the causes already mentioned, liable to extreme variation. It has been estimated that, of the whole quantity thus exhaled from the skin and from the lungs, about two-thirds are derived from the former source, and one-third from the latter.

Sect. III.—*Excretory Function of the Kidneys.*

By the neys.

(556.) A considerable proportion of fluid is also carried off from the system by the kidneys; the peculiar office of which, however, appears to be to eliminate more especially the saline materials, which are to be thrown off; and, in particular, the peculiar substance termed *urea*, which, as we have already remarked, partakes much of the character of resinous bodies. As urea contains a very large proportion of nitrogen, it is probable that the kidneys are the channels provided in the economy for the removal of any excess of this element which takes place in the system.

alysis of ne.

(557.) The chemical analysis of the urine has engaged the attention of a great number of physicians and philosophers, not only from its supposed connexion with various states of the body in health and disease, but also from its containing a great multitude of constituents, some of which have very peculiar properties. Above twenty different substances have been detected as entering into its composition; and almost every year is adding to the list of newly discovered ingredients. The existence of phosphorus in this fluid has long been known; and the urine was, till lately, the only source whence this elementary substance could be procured in any quantity. Scheele discovered the uric or lithic acid, which is one of the most remarkable of the animal products. The labours of Fourcroy and Vauquelin led to the knowledge of the exact composition of many of the neutral salts contained in the urine. This analysis was carried still farther by Cruickshank in England, and by Proust in Spain, but has been brought to its present state of perfection chiefly by the labours of Berzelius[3] in Sweden.

(558.) The daily quantity voided, as well as the sensible qualities of this secretion, is greatly modified by circumstances. The former has been estimated at an average as being about two pounds avoirdupois. Its mean specific gravity has been fixed at 1·03. In a healthy state it generally exhibits acid properties, arising from the presence of uncombined phosphoric, lactic, uric, benzoic, and carbonic acids. These acids, together with the muriatic and fluoric acids, also exist in combination with several earthy and alkaline bases, comprising ammonia, lime, magnesia, potass, and soda; the principal compounds thus formed being the phosphates of lime and magnesia, ammonia and soda, the sulphates of potass and of soda, the lactate of ammonia, the muriate of soda, and the fluate of lime. There exist, besides, a large proportion of urea, (composing nearly one-thirteenth of the whole quantity of urine, and about one half of its solid ingredients), mucus, gelatin, albumen, and a small portion of unacidified sulphur. The presence of a minute quantity of silica has also been detected by Berzelius, amounting to about the 220th part of the solid matter contained in the urine. The weight of the solid ingredients obtained by evaporation, is one-fifteenth of the whole fluid, the rest being water. The several ingredients above mentioned may each be rendered evident by the application of appropriate tests.

Urea.

(559.) Urea is a peculiar animal product, which is procured from urine evaporated to the consistence of a syrup and allowed to crystallize; after which alcohol is added, which dissolves the urea, whence that substance is obtained by evaporation. It then appears in the form of crystalline plates, and has a light yellow colour, a smell resembling garlic, and a strong acrid taste. It is chiefly characterised by the bulky flaky compound which it forms with nitric acid. By distillation it yields about two-thirds of its weight of carbonate of ammonia; and by spontaneous decomposition it is resolved into ammonia and acetic acid. It possesses the very remarkable property of changing the form of the crystals of common salt or muriate of soda, which, as is well known, usually crystallize in cubical crystals; but which, when mixed with a small quantity of urea, assume the form of octohedrons. What adds to the singularity of this effect is, that its operation is precisely the reverse on muriate of ammonia, or sal ammoniac; the ordinary form of the crystals of this salt are octohedrons, but when urea is present, they take the form of cubes. Urea contains a much larger proportion of nitrogen than any other animal principle. This substance has been found in the blood, after its separation by the kidneys has been prevented, by the extirpation of those glands. Berzelius has advanced an opinion, that urea is furnished by the animal matter of the serosity of the blood, from the similarity of some of its properties, and also from the circumstance, that after the kidneys have been removed, the animal matter of the serosity is first increased in quantity, and afterwards assumes the character of urea. It appears probable that the principal function of the kidney is the separation from the blood of the excess of nitrogen which it may contain, and its excretion in the form of urea; thus performing an operation with respect to this element analogous to that of the lungs with regard to the superfluous carbon of the blood.[4]

Sect. IV.—*Excretory Function of the Liver.*

4. Excretion by the liver.

(560.) Cholesterine, or the peculiar matter found in the bile, and which composes about eight per cent of that fluid, contains a large proportion of nitrogen. Whatever may be its uses in contributing to the formation of chyle, it is ultimately rejected from the body, and may therefore be classed among the excrementitious substances. We have already noticed the singular circumstance regarding the mode of its preparation, in being formed from venous instead of arterial blood, as is the case with all the other known secretions.

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[1] *Elementa Physiologie*, xii. 2, 11.

[2] *Mémoires de l'Académie des Sciences*, pour 1790, p. 601.

[3] *Annals of Physiology*, ii. 428.

[4] See Berard, *Annales de Chémie et de Physique*, v. 296.

(561.) It is doubtful how far these two peculiar substances, urea and cholesterine, may be considered as pre-existing in the blood, or as formed by the organs which respectively secrete them. It has been ascertained by the experiments of Prévost and Dumas, that in animals in whom the secretion of urine is suppressed by the removal of the kidneys, urea may, after some time, be detected in the blood; and Dr. Bostock ascertained that a similar substance makes its appearance in the human blood, in cases where the secretion of urine had been much obstructed by disease of the kidneys. The secretion from the liver is not liable to so much variation in its amount, as that from the other excernent organs; it is, however, diminished during febrile excitement and inflammatory conditions of the circulation, and increased by moderate exercise, and by external warmth. Both the liver and the kidneys, accordingly, may be ranked among the compensating organs, or those which have their actions occasionally increased in order to supply deficiencies in the functions of others. The excretion of watery fluid from the skin and lungs is evidently made to alternate with that from the kidneys, each of these organs being capable of occasionally supplying the office of the others. The chemical properties of the urine are very much influenced by the condition of the digestive functions. But the necessity of the excretion of urea is apparent from the rapidly fatal consequences which ensue from its accumulation in the system, when the secretion from the kidneys is suppressed, and which would lead to the conclusion, that this substance, when present in sufficient quantity, speedily acts on the nervous system as a virulent poison.

CHAP. XII.—NUTRITION.

Nutrition.

(562.) Nutrition consists in the appropriation of the materials furnished by the blood in the course of circulation, and modified by the processes of secretion, to the purposes of growth, and to the repair of that waste which is continually experienced by the solid structures of the body, in consequence of the exercise of their respective offices. We understand as little what are the particular processes by which these purposes are accomplished as we do respecting those of secretion. No mechanical or chemical hypothesis which can be devised appears at all adequate to the solution of this mysterious problem. The analogy of crystallization, implied in the celebrated definitions of Linnæus, in which the three kingdoms of nature are contrasted, is, in a philosophical point of view, utterly fallacious. According to this great naturalist, " minerals grow, vegetables grow and live, animals grow, live, and feel." It requires no lengthened argument to show that the growth of an animal, or of a plant, is a phenomenon belonging to a class entirely different from the increase of a mineral body. The latter is effected by the successive accretion of new layers of materials, which merely augment the volume of the body, without adding to it any new property; so that the separation of its parts destroys only the form of the aggregate, and not any of its essential qualities. But organized bodies are nourished from internal resources, and the materials which are incorporated with their substance have undergone a slow and gradual elaboration in the organs themselves, and have been assimilated to the qualities of the body of which they are to form a component part. We may consider them as the result of the operation of the organic affinities, to which we have already referred the phenomena of secretion.

Dependent on the circulation.

(563.) The only general fact of importance which has been established with regard to the succession of phenomena in this function, is. that the enlargement of any organ appears to depend essentially on the state of the circulation in that part, and on the supply of blood by its arteries. The increased growth of a part at any period, compared with that of neighbouring parts, is always preceded and accompanied by a marked enlargement of the arteries which furnish it with blood; and this is invariably observed, whether that growth be natural or morbid. A theory has been advanced, that nutrition is effected by the direct union of the red particles of the blood, or of their nuclei, with the tissues. This theory is successfully combated by Müller.[1]

(564.) Although we are unable to trace the exact nature of the processes of nutrition, yet much curious information may be collected by observing the succession of phenomena in the case of the formation of particular structures. Those which we shall select for the purpose of illustration are the bones and the teeth, in which the several stages of growth admit of being observed.

Sect. I.—*Ossification.*

Ossification.

(565.) The process of ossification is particularly interesting, from its exhibiting the operations of nature in the completion of an elaborate structure of such great importance in its mechanical relations to the system, as the osseous fabric. In the early periods of the fœtal state, we can but just trace the figures of some of the larger bones, which appear to be modelled in a soft gelatinous matter contained in a delicate membrane. This substance, as well as its membrane, acquires greater density, and the former assumes more the appearance of cartilage. In process of time, opaque white spots are perceived on different parts of its surface, which, when examined by the microscope, exhibit a fibrous appearance. These lines increase in number and extent; and after a time, red points are seen dispersed throughout the future bone, in consequence of the enlargement of the vessels which now admit the red globules of the blood. Soon after this, we find the earthy matter deposited in great abundance, imparting hardness and rigidity to the structure. In the long bones of the extremities, the osseous substance forms at first a short hollow cylinder, as if it were deposited from the vessels of the investing membrane, or periosteum. In the flat bones of the cranium, ossification commences from a few central points, and spreads on all sides, the fibres taking a radiating direction. In proportion as the bony material extends, the cartilage is removed by the absorbent vessels, in order to make room for the extension of the bone. After a certain time, in the cylindrical bones, a cavity is formed in the middle, in consequence of the absorption of central portions of cartilage and of bone which had occupied that situation. These two opposite processes of absorption and deposition continue during the whole of the future growth of the bone, the interior parts being removed in proportion as fresh bony layers are added at the exterior surface. Thus, when the outer part of the bone is compact and hard, the interior is either formed into a complete cavity, or into the cancellated structure formerly described.

Theorie

(566.) Such are the few well ascertained known facts relative to ossification; but numberless have been the speculations to which they have given rise. Most of the opinions of the ancients on this subject were extremely vague and hypothetical, and have been fully refuted by modern physiologists. Many of the hypotheses of the latter have undergone a similar fate. The one which has acquired most celebrity is that of Duhamel, who, following the analogy of the growth of trees, conceived that the bones were formed of concentric rings, or laminæ, deposited from the periosteum. He endeavoured to adduce in support of his theory the results of experiments in which bones acquired a red tinge, when madder was given with the food. He alleged that when the madder was occasionally intermitted, and again resumed, many times in succession, the bones of the animal exhibited alternate rings of a red and white colour, corresponding to the periods when the animal had taken madder, and had intermitted it. It has since been shown, however, that his imagination in this instance must have misled him; for no such result takes place under the circumstances he describes.

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[1] *Elements of Physiology*, translated by Baly, p. 359.

(567.) The reparation of fractured bones by the powers of the constitution is a striking instance of the beautiful provisions of nature for remedying injuries accidentally occurring to the body. The fractured ends are quickly united by a bony substance called *callus*, formed in a manner very similar to that by which the bone itself is originally constructed. The arteries near the seat of the injury pour out a kind of lymph, which coagulates, and is either gradually converted into cartilage, or replaced by cartilage after it has itself been absorbed. The deposition of phosphate of lime then takes place within this cartilage, which is either removed or adapted to its reception, and thus the ends of the bone are cemented together, and the limb rendered as firm as before the accident.

2. *Dentition.*

ntition.

(568.) No less curious and interesting is the process employed in the formation of the teeth. The rudiments of every tooth, when examined in the fœtus, consists of a gelatinous pulp, which is extremely vascular, enclosed in a double investment of membrane. The outer membrane is soft and spongy, and is apparently destitute of vessels; while the inner one is firmer, and extremely vascular. The first depositions are those of bony matter, which take place on the exterior surface of the vascular pulp, and chiefly on the upper part, but within the membranous coverings already noticed. The shell of bone thus formed has the shape of the future tooth, and acquires thickness from successive deposits of bone in its inner surface, which are still made by the outer surface of the vascular pulp. When the ossification is sufficiently advanced, the pulp which has thus served as a mould for the tooth, divides itself into two or more parts, corresponding to the intended number of fangs, so that the ossific matter is now deposited in the form of as many tubes round these portions of the pulp, and growing in a direction towards the jaw, forces the tooth in the contrary direction; thus in the lower jaw the tooth rises, and in the upper jaw it descends. The enamel is deposited after the body of the tooth is considerably advanced in its formation. It is the product of a secretion from the inner surface of the outermost of the two membranes, which form the capsule of the tooth, and the materials deposited from it adhere strongly to the bony crown of the tooth which they surround. This secreting capsule has been called the *chorion* by Herissant, who has given an accurate description of the process of dentition. Layer after layer of enamel is thus deposited, till the growth of that part of the tooth has been completed; then the chorion shrivels and is absorbed, and the tooth still continuing to grow at the root, pierces the gum, the resistance of which has been gradually diminishing by the absorption of its substance.

Sect. III.—*Nutrition of the Softer Textures.*

(569.) Greater difficulty exists in following the succession of changes which attend the growth and nutrition of the softer textures, than of those we have now considered, because the materials employed in their construction are less distinguishable by the eye from the other animal substances, and their changes are less easily traced, than those exhibited by the calcareous deposits of the osseous fabric.

A question here presents itself, of great importance with relation to our knowledge of the nature of the vital powers, but of which the solution is attended with the greatest difficulties. It is this: how far, it may be asked, are the powers of secretion exerted in merely separating from the blood those organic products which are already contained as ingredients of that fluid, and how far do they also extend to the actual formation of new proximate elements; and next, what reason is there to believe that the vital powers are capable of producing, from the materials presented to them, originally derived from the food, or the atmosphere, any quantity of those chemical substances, which, never having hitherto been decomposed, must, in the present state of the science, be regarded as elementary?

The consideration of the chemical analysis of the blood, and of the substances prepared from it will suffice to shew that most, if not all the secretions, may very possibly be produced solely by the operation of ordinary chemical affinities. It has been found, indeed, that we are able by certain chemical processes, to form from the blood, out of the body, substances similar to many of the secretions; and we are therefore warranted in the supposition that operations of the same kind are carried on by the secreting organs within the body. It is interesting, however, to trace the origin of many of the products of secretion, from the ingredients contained in the blood itself. On this subject Müller[1] remarks, that some of the proximate elements of the tissues exist in part ready formed in the blood. The albumen which enters into the composition of the brain and glands, and of many other structures, in a more or less modified state, is contained in the blood; the fibrin of the muscles and muscular structures is the coagulable matter dissolved in the lymph and blood; the fatty matter, which contains no nitrogen, exists in a free state in the chyle; the azotised and phosphoretted fatty matter of the brain and nerves exists in the blood combined with the fibrin, albumen, and cruorin. The iron of the hair, pigmentum nigrum, and crystalline lens, is also contained in the blood; the silica and manganese of the hair, and the fluor and calcium of the bones and of the teeth, have not hitherto been detected in the blood, probably from their existing in it in but very small proportion. The matters here enumerated are attracted from the blood by particles of the organs analogous to themselves, partly in the state in which they afterwards exist in the organs; in other instances, their ultimate elements are newly combined in them, so as to form new proximate principles; for the opinion that all the component elements of the organs exist previously in the blood in their perfect state, cannot possibly be adopted; the components of most tissues in fact present, besides many modifications of fibrin, albumen, fat, and osmazome, other perfectly peculiar matters, such as the gelatin of the bones, tendons, and cartilages, nothing analogous to which is contained in the blood. The substance of the vascular tissue, and also the different glandular substances, cannot be referred to any of the simple components of the blood. Even the fibrin of muscle cannot be considered as exactly identical with the fibrin of the liquor sanguinis. Between coagulated fibrin and coagulated albumen, there is scarcely any chemical difference, except in their action on peroxide of hydrogen; the only very important distinction between the fibrin dissolved in the blood and the albumen is, that the former coagulates as soon as it is withdrawn from the animal body, while the latter does not coagulate spontaneously, but requires a heat of from 158° to 167° Fahr., or some chemical agents, such as acids, concentrated solutions of fixed alkali, or metallic salts; and the fibrin of muscle in its chemical characters has scarcely a greater analogy with coagulated fibrin, than with coagulated albumen. In its vital properties the fibrin of muscle differs from both. The comparison of nervous substance, again, with the fatty matter containing nitrogen and phosphorus, is only justified by the present imperfect state of organic chemistry.

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[1] *Physiology, &c.* p. 361.

The blood, as Dr. Bostock[1] observes, is a substance, the composition of which is peculiarly well adapted to undergo the changes necessary for the processes both of secretion and of nutrition, as it consists of a number of ingredients, which are held together by a weak affinity, liable to be disturbed by a variety even of what might appear the slightest causes. As examples of the facility with which these changes may be effected, we may cite the numerous reagents which have the power of coagulating albumen; the action upon it and upon fibrin of dilute nitric acid, which converts these substances respectively into adipose matter and jelly, changes which are probably the result of the addition of oxygen to the fibrin and to the albumen; and there is some reason to believe that by applying the same reagent to the red particles, we may obtain a substance nearly resembling bile.

With regard to the formation of the saline secretions,[2] and of those substances, the elements of which are not to be found in the blood, or at least not in sufficient quantity to account for the great accumulation that takes place in certain parts of the system, and of which the source is not apparent, we must confess that the present state of the science affords no means of explaining the phenomena. "To suppose," as Dr. Bostock justly remarks, "that we are affording any real explanation by ascribing it to the operation of the vital principle, or to any vital affinities, which is merely a less simple mode of expressing the fact, is one of those delusive attempts to substitute words for ideas, which have so much tended to retard the progress of physiological science."

Sect. IV.—*General Phenomena of Nutrition.*

(570.) The instances we have above given of the processes employed in ossification and dentition, together with the varied operations concerned in the formation and nutrition of all the softer textures of the body, forcibly illustrate the beneficent care displayed in the construction of every part of the frame, and the admirable adjustment of the long series of means which have been provided for the attainment of these diversified and frequently remote objects of the animal economy. Every part undergoes a continued and progressive change of the particles which compose it, even though it remain to all outward appearance the same. The materials which had been united together by the powers of nutrition, and fashioned into the several organs, are themselves severally and successively removed and replaced by others, which again are in their turn discarded, and new ones substituted in their place, until, in process of time, scarcely any portion of the substance originally constituting the organs remains as their component part.

Renewal of materials.

(571.) We see from the examples of the bones, that this continual renovation of the materials of the body takes place in the most solid, as well as in the softest textures; and so great is the total amount of these changes, that doubts may reasonably be entertained as to the identity of any part of the body at different epochs of its existence. The ancients assigned a period of seven years as the time required for the complete renovation of all the materials of the system, but perhaps this entire change may take place during a shorter interval.[3]

Balance of powers.

(572.) The two functions we have been considering, namely, nutrition and absorption, may be regarded as antagonist powers, each continually counteracting the effects of the other. In the early periods of life, though both are in full activity, the former predominates; all the organs enlarging in their dimensions by the addition of fresh materials in greater quantity than the losses by absorption, the whole body is in a state of growth. In the course of time, the frame having attained its prescribed dimensions, these opposite processes of reparation and decay approach nearer to an equality; and at length are exactly balanced. The parts then cease to grow, and the system may be said to have reached its state of maturity. This is the condition of the adult, in which the equilibrium of the functions is maintained for a great number of years. At length, however, the period arrives when the balance, hitherto so evenly kept, begins to incline, the renovating powers of the system are less equal to the demands made upon them, and the waste of the body exceeds the supply. It contracts in its dimensions; it has attained its period of declension, which marks the progress of age, and ultimately leads to decrepitude. The fabric then betrays unequivocal symptoms of decay, the functions are imperfectly performed, the vigour of the circulation flags, the flame flickers in the socket, and is finally extinguished in death. Thus is the whole duration of life, from the first developement of the germ to the period of its dissolution, occupied by a series of actions and reactions, perpetually varying, yet constantly tending to definite and salutary ends.

(573.) We have now concluded the account we proposed to give of the long series of functions which maintain the various organs of the system in that mechanical condition and chemical composition fitting them for the exercise of their several offices in the economy. We have next to enter into the consideration of the higher order of functions connected with the nervous system.

CHAP. XIII.—THE SENSORIAL FUNCTIONS.

Sect. I.—*General Views.*

Objects sensoria function

(574.) The functions we have hitherto considered, however admirably contrived, and beautifully adjusted, are calculated only for the maintenance of a simply vital existence. All that is obtained by their means is a mass of organized materials, which lives, which is nourished, which grows, which declines, and which perishes in a certain definite period, by its mere internal mechanism. But these can never be the real ends of animal existence. Sensation, voluntary motion, pleasure and pain, together with all the intellectual operations to which they lead, these must be the proper objects of animal life; these the purposes for which the animal was created. In man we find the extension of these latter faculties to an extraordinary degree, and the addition of moral attributes which elevate him so far above the brute creation, and place him one step nearer to that divine essence after whose likeness he was made.

(575.) The functions of sensation, of voluntary motion, and of thought, are those which establish our mental connexions with the external world; which enable us to acquire a knowledge of the existence and properties of the material objects that surround us; which awaken in us the operations of our own minds; which bring us in communication with other intellectual and sentient beings, and which enables us to react on matter, to exercise over it the dominion of the will, and to influence the condition of those other beings which like us have received the gift of life, of sensation, and of intellect.

Distinc between matter and mi

(576.) Throughout the whole of the inquiries in which we are about to engage it is important to keep steadily in view the essential and fundamental distinction between mind and matter. Of the existence of our own sensations, ideas, thoughts, and volitions, we have the highest degree of evidence that human knowledge can admit of, that of our own consciousness. Of the existence of matter, that is, of causes foreign to our own mind, but acting on it, and giving rise to sensations, which are strictly mental affections, we have merely a strong presumption; still, however, the belief in the existence of those causes, however irresistibly it may operate in producing in us convictions, and influencing our actions, is yet but an inference from the regularity in the succession of our sensations. We are not justified in saying that it is impossible we can be deceived in this belief; whereas in the consciousness of our mental existence we cannot possibly be mistaken, because that consciousness implies the very fact of our existence.

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[1] *Elementary System of Physiology*, p. 518.

[2] *Ibid.* p. 532.

[3] See the article Age, in the *Cyclopædia of Practical Medicine*, vol. i. p. 34.

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(577.) It is, however, most true, that notwithstanding our ideas of mind and matter are such as wholly to exclude our conceiving any property to belong to both of them in common; yet some inscrutable link of connexion has, in our present state of existence, been established between them, so that each may, under certain circumstances, be affected by the other. External matter acts on our bodily organs, which are still mere matter; but our bodily organs act on our minds; and our minds in turn react on our bodily organs, and occasion movements which enable us to act on extraneous objects. Moreover, it is impossible for us in our present state to carry on any intellectual operation, but by the instrumentality of our material organs; we can neither feel, nor think, nor will, without the healthy condition of the brain, and all the other physical conditions which such a state implies. Disturbance of the physiological functions of the brain is invariably attended by a disturbance of the mental operations connected with those functions. Both are excited by certain states of the circulation in the brain; both are instantly suspended by pressure upon that organ; both are restored by the removal of the pressure, or other disturbing cause.

e ner s sys-

(578.) The *nervous system* is the name given to that assemblage of organs which perform the important functions of which we are now speaking. The primary office of the fibres composing that system appears to be to transmit certain affections, which we may call *impressions*, from one part of that system to another; and more particularly to convey them both to and from that particular part of the brain, the affections of which give rise to sensation, and accompany our mental operations. In the one case, the impression made on one extremity of a nervous fibril, adapted to receive such impression, in a part called an *organ of sense*, is propagated to the part of the brain above described, and to which the name of *sensorium* has been given, and thereby producing a certain physical effect, the nature of which is wholly unknown; *sensation*, which is a mental effect, ensues. In another case, the fibres of the brain are by their action instrumental in retracing, in combining, in modifying these impressions, and forming them into ideas, which are linked together by the laws of association. Again, the mental act we term *volition*, and of which we are always conscious, affects some particular fibres or portion of the sensorium, the impression made upon which is followed by an affection of certain nervous filaments proceeding from those parts of the brain, and conveying an influence, (which for want of a more specific term we may also call *irritation*), to the muscles in which these nerves terminate; and this is immediately followed by the contraction of those muscles. This constitutes *voluntary motion*.

(579.) But the office of the nerves extends yet farther. Various muscles subservient to many of the vital functions, such as the heart, the stomach, and the intestines, act without any interference, or even control of the will. They compose the class of *involuntary muscles;* yet these muscles are supplied with nerves, and have a certain dependence on the nervous system, which is of a very peculiar kind, and will be considered afterwards. These nerves supplying the involuntary muscles, appear to have the office of establishing connexions between the actions of these muscles, and of uniting the various organs of the different functions into one connected harmonious whole.

Series of actions.

(580.) Thus the various phenomena which relate to the nervous system in the performance of the functions we are considering, will arrange themselves under the following heads, according to the natural order of their sequence:

First, the impressions made by external objects on the sentient extremities of the nerves distributed to the organs of sense, through the medium of those organs.

Secondly, the transmission of the impressions so made to the sensorium, through the medium of the nerves of sensation.

Thirdly, the physical changes made on the sensorium.

Fourthly, the mental change consequent on this physical change in the sensorium; which mental change is termed *sensation;* and in experiencing which the mind is wholly passive.

Fifthly, the recurrence, associations, and combinations of the physical changes originally induced in the sensorium, but probably extended through various parts of the substance of the brain, and simultaneous with various mental operations, in exercising which the mind is partly passive and partly active.

Sixthly, the mental act denominated *volition*, which is accompanied with consciousness, and in which the mind is wholly active.

Seventhly, the corresponding change induced by volition on the sensorium, or origin of the nerves of voluntary motion.

Eighthly, the transmission of the impression so received by the nerves of voluntary motion, to the muscles on which they are distributed.

Ninthly, the contractions of these muscles, constituting voluntary motion.

Tenthly, the influence of the nerves on the muscles of involuntary motion, and on various functions apparently depending on involuntary actions.[1]

Sect. II.—*Organization of the Nervous System.*

Division of the nervous system.

(581.) The nervous system comprises organs of a curious and complicated structure, and which are of the highest importance in the animal economy. Their study is exceedingly interesting, whether they be viewed as instruments of sensation, as sources of action, or as the medium of connexion between the body and the mind. This system is composed of a considerable mass of a soft pulpy substance called the *brain*, which occupies the cavity of the skull; a prolongation of this substance filling the canal of the spine, and called the *spinal cord*, or *spinal marrow;* and of various processes in the form of cords, called *nerves*, which extend from the brain and spinal cord, to almost all parts of the body. There are found also interspersed in various parts along the course of the nerves, small rounded or flattened bodies, called *ganglia*, which also belong to this system of organs. All the parts of this system are intimately related to each other, and although they differ considerably in their general appearance, they possess many characters in common. In point of structure they present us with three different modifications; the first comprehending the substance of the central masses, which include the brain and spinal cord; the second, the nerves; and the third, the ganglia. We shall proceed to consider each of these in the above order.

1. *Organization of the Brain and Spinal Cord.*

Structure of the brain.

(582.) *The brain*, or general mass which fills the cavity of the skull, is composed of a number of parts of various shapes, the particular forms and dispositions of which belong properly to descriptive anatomy. It will be sufficient for our present purpose to state, that it is divided into three masses, distinguished by the names of *cerebrum*, which is by far the largest portion, and which occupies the whole of the upper and fore part of the cavity of the skull; the *cerebellum*, or lesser brain, which is situated at the hinder and lower part of the cerebrum; and the *medulla oblongata*, which lies at the central part of the base, or inner surface of the cerebrum, and connects it with the cerebellum, and with the spinal cord. All these parts, as well as the spinal cord itself, are formed of two kinds of substance; the *cineritious*, or ash-coloured substance, which has also been called the *cortical* substance; and the white, or *medullary* substance. These two substances are variously intermixed, sometimes forming strata of different thickness, and sometimes the one enveloping separate portions of the other, in different parts of the whole mass. There is a layer of cortical substance placed on the outside of the cerebrum; it does not, however, form a smooth uniform plane, but is moulded into *convolutions*. In the cerebellum there is a similar superficial stratum formed into concentric laminæ. The convolutions are of considerable depth; and if any of them be cut through, it is seen to consist of both cortical and medullary substance. The cortical forms a layer of considerable thickness; and on looking attentively on its divided edge, a very narrow lamina of medullary substance will be perceived passing through it, and following it through all its windings. This fact has been particularly noticed by Dr. Baillie. The concentric laminæ on the surface of the cerebellum, are composed also of cortical and medullary matter. By this arrangement, the quantity of cortical substance, as well as the extent of its surface on the outer part of the brain, is very much increased.

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[1] See *Bridgewater Treatise on Animal and Vegetable Physiology*, vol. ii. p. 535, note.

(583.) In the interior of the brain we find cavities of considerable size, termed *ventricles*, and bodies of regular, but various shapes, presenting many different mixtures of two species of matter. Where these bodies appear, from their outside, to be formed of cortical substance only, on cutting into this, there is found a considerable mixture of medullary matter; and where they seem, from their outside, to be formed of medullary matter alone, they are discovered, on dividing them, to contain some cortical substance in the interior. Thus, there is no particular part of the brain composed purely of the one kind of substance or the other; although the proportions of each in the various parts may be very different. A similar intermixture of cortical and medullary matter exists in the spinal cord; but contrary to what takes place in the large mass of the brain, the cortical part is placed in the interior, and is enveloped by the medullary.

(584.) The medullary substance has generally been considered as constituting the most perfect state of nervous matter, or that which more especially exercises the functions of the nervous system. Some physiologists, on the contrary, consider the grey substance as the seat or origin of nervous power; while the fibres of the white substance act merely the part of conductors of nervous influence from one part to another. This medullary portion is obviously of a firmer consistence than the cortical part, and contains fewer blood-vessels interspersed throughout its substance. Both the one and the other are almost perfectly homogeneous in their appearance. Ruysch had fancied that the cortical substance was entirely composed of blood-vessels, connected by cellular membrane; and in this opinion he was for a long time generally followed, although the pulpy consistence it exhibits is scarcely compatible with such a notion. Malpighi supposed that he had detected in it a glandular structure; but this must also be regarded as a mere hypothesis, unsupported by any substantial evidence. The medullary matter presents traces of a fibrous structure; a fact which was first observed by Malpighi, and which is particularly insisted on by Drs. Gall and Spurzheim; and notwithstanding the existence of such a structure is denied by other eminent anatomists, it appears to have been sufficiently established by the elaborate researches of Reil, a detailed account of which has been given by Mr. Mayo.[1]

Microscopic structure.

(585.) Anatomists are far from being agreed as to the minute and ultimate structure of nervous matter. De la Torré asserts that it consists of a mass of innumerable transparent globules immersed in a transparent fluid; and that these globules are larger in the brain than in the spinal marrow. Prochaska describes the same globular structure, which he represents as united by a transparent elastic cellular membrane disposed in fibres. Monro,[2] in his first inquiries, thought that these fibres were convoluted, but afterwards acknowledged that he had been misled by an optical fallacy, incident to the employment of high magnifying powers. The Wenzells[3] also recognised the globular composition of the nervous substance, and considered the globules themselves to be vesicles filled with a material either of a medullary or cineritious appearance, according to the portion examined. Bauer[4] states that the globules are of about the same diameter as the central particles of the globules of the blood, some, however, being still smaller; and that they are of a gelatinous consistence, and soluble in water. The cineritious substance, he finds, is composed chiefly of the smallest globules, surrounded by a large proportion of a gelatinous and serous fluid. The medullary substance, on the other hand, is formed principally by the larger and more distinct globules which adhere together in lines, and have a smaller proportion of fluid, that fluid being more viscid than in the cineritious substance. Dr. Edwards[5] has confirmed by his observations, these results, as far as the general globular composition of nervous matter is concerned. He asserts the diameter of the globules to be one three-hundredth of a millimetre, which is equivalent to the seven thousand six hundred part of an inch; and that these globules are arranged in linear series, constituting the primary linear fibres. Beclard states that he has verified these observations.[6]

2. *The Nerves.*

Nerves.

(586.) The *nerves* are white cords extending from different parts of the brain and spinal cord, to different parts of the body, and more especially to the muscles, the integuments, and other organs of sense, and to the viscera and blood-vessels. Their general form is cylindrical; but they divide, in their course, into a great number of branches, many of which again reunite, or are joined with the branches of other nerves, so as to form in many parts a complicated nervous net-work, or *plexus*, as it has been termed by anatomists. The nerves are usually spoken of as originating in the brain or spinal cord, and as proceeding from thence to their termination in other, and generally distant parts. As the united branches would form a cord of much larger diameter than the trunk from which they arise, it is evident that the total quantity of nervous matter they contain is augmented as they proceed in their course. When examined with the microscope, their surface presents a number of transverse lines or wrinkles, which are evidently for the purpose of admitting of flexion; and thus accommodating them to the different movements of the parts with which they are connected.

Neurilem

(587.) The nerves appear to consist of filaments of medullary substance, enclosed in a tough cellular membrane.

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[1] In his *Anatomical and Physical Commentaries*.

[2] On the *Nervous System*.

[3] *De Structura Cerebri*.

[4] *Philosophical Transactions* for 1818, and 1821.

[5] *Sur la Structure élémentaire*.

[6] See his *Anatomie Générale*.

At their origin from the central organ, whether it be the brain or the spinal cord, they consist of detached fibrils, sometimes isolated, but in general arranged so as to constitute flat bands. There are two such bands, namely, an anterior and a posterior fasciculus, which unite to form each of the nerves arising from the spinal cord. Some nerves are composed of pure medullary matter, as the optic nerve; but in the greater number this matter is so enveloped in a tough cellular membrane, which has been termed by anatomists the *neurilema*, that it cannot distinctly be perceived. In the olfactory nerves there is an evident junction of cortical with medullary matter, but in most others we find nothing but filaments of medullary matter, each of which is contained in a separate envelope of neurilema, that forms tubes for their reception.

(588.) Many anatomists have attempted the investigation of the minute structure of nervous fibrils by means of the microscope. De la Torré[1] perceived in them globules similar to those of which the matter of the brain is composed. Monro[2] and Fontana describe the nervous filaments as being connected by cellular substance, much in the same way as the muscular fibres, and arranged like them in fasciculi of various sizes. They represent the ultimate fibril as being twelve times greater than the muscular fibre, having a serpentine or tortuous form, and being composed of a cylindrical canal, containing a viscid pulpy matter, evidently different from the substance of the canal itself. Reil has pursued this investigation with still greater care and minuteness, and states that the ultimate filaments differ in thickness from that of a hair to the finest fibre of silk. Their arrangement into larger and larger fasciculi is analogous to what we observe in the structure of muscles, but with this difference, that the nervous fibres in their course along the nerve, frequently divide and subdivide, and are again variously united and conjoined, so as to produce an extensive connexion among all the parts of the same nerve. The membranous neurilema, besides giving support to each individual filament of nerve, and uniting them into fasciculi, furnishes also a general covering to the whole nerve.

(589.) What has now been stated must be understood as applicable to nerves in general. Many differences have been pointed out in the structure of different nerves; but it is not necessary to descend into these minute particulars in the general view we are now giving.

3. *Ganglia.*

glia.

(590.) *Ganglia* are small rounded nodules, which are placed in different situations in the course of nerves, sometimes in the trunk of a single nerve, and sometimes where two nerves unite. They are most numerous on those nerves which are distributed to the viscera, and to the muscles of involuntary motion. Their appearance is very different from that of a mere dilatation of a nerve, being of a reddish-brown colour, having a minute fibrous texture, a firmer consistence, and a greater number of blood-vessels than ordinary nerves. The nerves which pass out from a ganglion are generally of a larger size than those which entered into it, as if they had received, in their passage through it, an additional quantity of matter. It would appear, from numerous observations, that the filaments of the different nerves which join the ganglion proceed through it individually without interruption, but are, at the same time, involved and twisted together in a very complicated manner; the result being, that filaments from many different nerves are united in the formation of a new nerve; so that the parts to which the nerve is distributed receive a supply of filaments from many different sources, and are in very extensive communication with various parts of the brain, spinal cord, and indeed the whole nervous system.

(591.) Besides this junction and intertexture of nervous filaments, the ganglia contain a soft semi-fluid matter, which appears to be analogous to the proper substance of the brain, and like the latter, may be distinguished into cineretious and medullary portions. It would appear, therefore, that the ganglia have some peculiar office with regard to the nerves which traverse them, and that they do not serve the purpose only of a plexus of filaments, establishing mere mechanical connexions between them, as some anatomists have alleged.

CHAP. XIV.—THE EXTERNAL SENSES.

External senses.

(592.) The external senses have usually been reckoned five in number, namely, touch, taste, smell, hearing, and sight; but this arrangement has reference more to the organs by which they are exercised than to the nature of the sensations they excite in the mind. A variety of sensations have been referred to the sense of touch, which are wholly different in their kind, and which are received by means of impressions made on the skin, and also others which are conveyed by nerves in other parts of the body, without any connexion with the skin. These we shall notice after we have considered the sensations more peculiarly belonging to the sense of touch.

SECT. I.—*Touch.*

1. *Sensation of Pressure.*

Touch.

(593.) Every part of the surface of the body is exposed to the contact of foreign bodies; and in most parts of the skin very slight pressure made by those bodies gives occasion to the primary sensation of touch, which is in fact simply that of resistance to the part of the skin on which it presses. This sensation is quite specific, and distinguishable from all other sensations. It may be conveyed, though less perfectly, by several of the internal surfaces of the body, as those of the mouth and pharynx. Certain parts of the skin possess, however, a more peculiar delicacy of nervous sensibility to the impressions of touch, and are therefore to be considered as more especially the organs of this sense. In man the points of the fingers are particularly employed for receiving the finer impressions of touch, and for distinguishing the qualities of external objects, of which this sense is fitted to convey us information. The greater vascularity of the skin of the fingers, and greater developement of its papillary structure, have been assigned as the causes of the apparent increase of sensibility with which they have been endowed. There is no doubt, however, that much depends on the education given to the ends of the fingers, by their constant employment in this office; for we find that the toes and other parts of the body may, by use, be trained to the acquisition of an equal degree of sensibility; of this we see examples in individuals who have been born without hands. Parts where the epidermis is very thin, such as the lips, are also endowed with considerable sensibility to the impressions of touch, and with the power of discriminating differences in those impressions which cannot be felt or appreciated by means of the fingers.

(594) Professor Weber of Leipsig[4] has made a series of very interesting experiments on the relative sensibilities of the skin in different parts of the body, with reference more particularly to its power of conveying to the mind accurate perceptions of mechanical impressions made upon it. He found this power possessed in the highest degree by the tip of the tongue and ends of the fingers, the sensibility of

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[1] *Philosophical Transactions* for 1769.

[2] *On the Nervous System.*

[3] An account of these researches is contained in the *Edinburgh Medical Journal*, xl. p. 83.

which he estimated at eighty times greater than that of the skin of other parts of the body. He observed, also, that even the skin in different parts of the face, when touched with the points of a pair of compasses opened to a small distance, shewed the greatest diversity in their power of conveying distinct perceptions of touch as to the object in contact being single or double, and as to the distance between the points, when they were perceived to be double.

2. *Sensations of Temperature.*

Sense of heat and cold.

(595.) The same organs which, when pressed by an external body, convey the impression of resistance, communicate also sensations of heat and cold, and nearly in the same relative proportion. Thus the fingers are more sensible to variations of temperature in the bodies they touch than other parts of the skin less accustomed to discriminate them. The lips are still more sensible than the fingers to the differences of temperature in the bodies to which they are applied. This peculiar sensibility affords a ready mode of distinguishing genuine diamonds and other precious stones from such as are counterfeit; for the former, being better conductors of heat, produce a more lasting impression of coldness when applied to the lips or to the tongue.

The sensations of heat and cold are, however, far from being in exact proportion either to the actual temperatures of the bodies which are in contact with the skin, or even to the differences between their temperature and that of the skin. The actual condition of the sensibility of the skin at the time, which depends on a multitude of causes hereafter to be noticed, has a very considerable influence on the sensations. The difference which is observable in the sensibilities of the same part to the impression of resistance, and to that of heat or cold, suggests a doubt whether a different set of nerves may not be employed to transmit to the brain these different kinds of impressions. We find in certain states of disease, that the general sensibility of the surface of the body may be much impaired, and yet it may preserve its sensitiveness with regard to heat and cold; and it is also certain, that differences of temperature produce sensations in parts, the stomach for instance, which are wholly disqualified from communicating the feeling of resistance.

3. *Anomalous Sensations.*

Hunger and thirst.

(596.) Hunger and thirst are sensations referred to the mouth, throat, and stomach, which are also quite specific in their nature, though generally referred to the sense of touch.

Peculiar sensations.

(597.) The same observation applies to a variety of peculiar sensations, many of which are common to the whole surface of the body, and may even be felt in some internal parts, but which it would be difficult to class, or even completely enumerate. The sense of tingling and of itching are examples of this species of sensations. The feeling of nausea is an undefinable sensation referred to the stomach.

4. *Sensation of Pain.*

Pain.

(598.) Every sensation thus referred to the sense of touch, when it rises beyond a certain degree, is accompanied with the additional feeling of pain, which, if considerable, engrosses the whole attention, and effaces all marks of discrimination as to its origin. Pain is generally readily referred to a particular part of the body, as being the origin, or as it is commonly called, the *seat* of pain, especially when the part is external. But in internal parts, this specific reference is often extremely vague and imperfect; and there frequently exists a general feeling of uneasiness, often more intolerable than any other, and to which it is impossible to assign any particular locality. It may also be observed, that in general the actual sensibility bears no relation to the capacity for feeling pain.

(599) A vast number of experiments were made by Haller, with a view to ascertain the comparative sensibilities of the different textures and organs of the body. In general, those which have but a small degree of vascularity, such as the cartilages, tendons, ligaments, fibrous membranes, and bones, and even the simple cellular texture, and serous membranes, in a state of health, have a very obscure degree of sensibility, when cut across, pricked with a pointed instrument, or burned by a hot iron. Yet many of these textures, though deficient in sensibility to these stimuli, are yet extremely sensible to injuries of another kind, namely, forcible stretching, when applied suddenly and in a degree which endangers the integrity of their structure. This is sufficiently illustrated by the acute pain attendant on a sprain. Bones, also, though scarcely communicating any feeling of pain when sawn through in the living body, yet feel acutely the concussion produced by violent blows, as any one may be convinced of who has suffered a blow on the knee. It is also remarkable that all those parts, which are apparently so incapable of sensation under ordinary circumstances, become highly sensible when in a state of inflammation.

(600.) The internal parts of most of the glands and other solid organs, have but little sensibility; and the chief source of pain, when they are attacked with inflammation, arises from the affection spreading to the membranes which invest them. Inflammation of the mucous membranes does not occasion any proportionate degree of pain. Those parts of the body which receive no blood-vessels, as the cuticle and its appendages, the nails and the hair, are absolutely insensible. The cuticle consequently is well adapted to protect the highly sensitive organ which it covers, and to blunt its sensibility.

(601.) Pain often arises from internal causes; from pressure, or distension, or other mechanical or chemical irritation applied to nerves; or from some changes taking place in the texture of the nerve itself. It will appear evident, on a general review of the sensibility allotted to the different organs of the body, that each has received from nature that particular kind and degree which is most needed, and which best accords with the relative importance of its functions, and the dangers to which, in the ordinary course of events, it is exposed.

5. *The Muscular Sense.*

Muscular sense.

(602.) A very important class of sensations has been referred to the sense of touch, which require to be particularly distinguished from the rest; they are those attending the contractions of the voluntary muscles, which render us sensible of the movements of our limbs, and of other parts which are voluntarily moved. These are the feelings which give rise to the idea of extension, and which, combined with the feeling of resistance, communicate to us a knowledge of the forms, magnitudes, and relative positions of external objects. Thus, by moving the hand over the surfaces of bodies, we gain the ideas of their tangible extension together with most of their mechanical properties, such as their roughness, hardness, weight, texture, and dimensions. In these examinations we avail ourselves of the admirable properties of the hand, an instrument which, by the number and variety of its parts, and the motions of which they are capable, is exquisitely fitted for procuring us this useful kind of knowledge. By the perceptions we acquire in infancy from the active employment of the limbs in various kinds of progressive motion, our sphere of knowledge of the material world is prodigiously extended; and these perceptions are an important source of gratification, in consequence of the feelings of pleasure with which, by the beneficent ordination of nature, the active exercise of the voluntary muscles is accompanied.

(603.) The sense of touch, in the comprehensive view which we have now taken of it, is unquestionably the most important of all our external senses, bringing us more immediately acquainted with the essential qualities of the material world, and laying the great foundations of all the knowledge which the other senses supply, by a reference to the ideas derived from touch.

Sect. II.—*Taste.*

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(604.) It was the fashion among the French metaphysicians to resolve all the senses into that of touch; so that in speaking of vision, for instance, they would allege that we see by means of the light which touches the retina. But this is a mere refinement not warranted by facts, and in which the real distinctions existing among the sensations themselves are overlooked.

(605.) If any of the senses could be considered as a finer sense of touch, it would be that of taste, by which we receive impressions of a peculiar kind from the sapid qualities of bodies in contact with the upper surface of the tongue. This sense is manifestly intended to guide us in the choice of our food, and it is accordingly placed at the entrance of the alimentary canal.

1. *Organs of Taste.*

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(606.) The principal organ of taste is the *tongue*, but several of the neighbouring organs are auxiliaries in the exercise of this sense. The soft parts of the mouth consist of the lips and cheeks, the gums, the soft palate, the velum, uvula, tongue, the membranous lining of the mouth, and the salivary glands. The osseous parts are the upper and lower maxillary bones, the teeth, and the palate bones.

(607.) The *lips* and *cheeks* are principally composed of muscles; they are covered on the outside by the common integuments, and lined within by the membrane of the mouth, in which are situated numerous mucous glands. The membrane of the mouth is covered with fine villi, which are most conspicuous on the edges of the lips. A small doubling of this membrane is met with in the middle of both the upper and under lips, which fixes them more closely to the jaws. They have been termed the *frœna labiorum.* The union of the lips at the corners of the mouth form what has been called the *commissures* of the lips.

(608.) The *gums*, which surround, and firmly adhere to the collar of the teeth, are very vascular, and composed of a dense and compact cellular substance.

(609.) The *palate* is divided into the *palatum durum*, and *palatum molle.* The former is composed of the palate plates of the upper jaw, covered by periosteum, and by the membrane of the mouth, which here forms numerous rugæ. The *soft palate*, or *velum pendulum palati*, is the name of that membranous curtain which hangs from the posterior edge of the ossa palati, and pterygoid processes, and forms a flexible partition between the mouth and throat. It serves to conduct the fluids of the nose downwards, and at the same time acts as a valve in preventing the passage into the nostrils of what is swallowed. In the middle of the edge of the velum, a conical papilla, termed the *uvula*, is met with, and in the relaxed state hangs pendulous over the root of the tongue.

gue.

(610.) The *tongue* is a complex organ, principally consisting of a mass of muscular fibres, irregularly disposed, and crossing each other in a great variety of directions, and being also intermixed with a soft kind of fat. It is invested by a mucous membrane, being a continuation of that which lines the mouth generally, and which here presents large and numerous *papillæ.* These papillæ are distinguished by anatomists into three kinds, according to their size, form, and situation. The first class of these, called *papillæ maximæ, lenticulares*, or *capitatæ*, are by much the largest, have a lenticular form, with round heads and short stems. They are placed at the base of the tongue, in superficial fossulæ. They have been regarded as auxiliary salivary glands, and have each a perforation in the middle of their convex surface for the excretion of mucus. The second class, or *papillæ mediæ*, or *semi-lenticulares*, are much smaller than the former, and are scattered over the upper surface of the tongue, at some distance from each other; their form is cylindric, while some are terminated by a round, but not dilated extremity. Others are more or less tuberculated at the summit. The third class, or *papillæ minimæ*, which have also been termed *conicæ*, or *villosæ*, are exceedingly numerous, but of very minute size. They cover almost the whole of the upper surface of the tongue, but are most abundant towards the tip, where the sense of taste is most acute.

(611.) The membrane covering the root of the tongue abounds with *mucous follicles.* At the root of the tongue, and behind the papillæ maximæ, there is a hole or deep depression, called the *foramen cœcum Morgagni*, which penetrates only a small way into the substance of the tongue, and receives the mouths of several excretory ducts that open into it. A line is also observable running forwards along the middle of the tongue, from the foramen cœcum; this is the *linea linguæ mediana.* The tongue is somewhat restrained in its motions by the *frænum linguæ*, which is formed by a duplicature of membrane at its under part, connecting it with the jaw.

Salivary glands.

(612.) All sapid substances require, in order to produce an impression of taste, to be applied in a state of solution to the nerves of that sense. Nature has accordingly provided a fluid secretion for the purpose of effecting their solution, and diffusing them over a sufficient extent of the surface of the tongue. This secretion, which is the saliva, is prepared by the *salivary glands*, which consist of three large glands on each side of the face, namely, the *parotid*, the *submaxillary*, and the *sublingual.* The parotid is the largest of the three, and occupies the whole space between the ear and the angle of the lower jaw; its excretory duct, called *Steno's salivary duct*, passes off from the upper and fore part of the gland, and perforates the buccinator muscle, so as to open in the inside of the cheeks, opposite to the second or third molar tooth of the upper jaw. The *submaxillary*, or *inferior maxillary* gland, is situated on the inside of the angle of the lower jaw; its duct is called the *ductus Whartonii*, and it terminates by a small orifice on the surface of a papilla on the side of the frænum linguæ. The *sublingual gland* is still smaller, and is under the anterior portion of the tongue above the duct of Wharton, and its ducts open by several orifices arranged in a line near the gums, a little to the outside of the frænum. The smaller salivary glands of the mouth are very numerous, and are named from their situation, *buccales, labiales, palatinæ*, and *linguales.*

2. *Function of Taste.*

Classification of tastes.

(613.) Attempts have often been made, but with no great success, to establish a classification of tastes. The general characters of the tastes denominated acid, sweet, bitter, saline, alkaline, aromatic, astringent, acrid, and spirituous, are sufficiently known, but their combinations are endless; and there exists besides these, a greater number of other tastes, which it would be impossible to reduce to any of the above classes.

(614.) The principle on which sapid bodies act upon the tongue is probably resolvable in all cases into chemical action. It is observed, accordingly, that substances which are in a solid form, and absolutely insoluble in the saliva, are invariably tasteless; just as in chemistry it is an established axiom that bodies do not act chemically unless they are either in a liquid or gaseous state. Mr. Mayo observes, that the sensations of taste are not perfect until the mouth is closed, and the tongue pressed against the palate, by which means the sapid liquid is brought into more exact contact with the surface of the tongue, and perhaps forced into the texture of its mucous membrane.

Seat of the sense.

(615.) The organ of taste appears to be exclusively the upper and papillated surface of the tongue; for although the impressions of this sense are often referred to the palate, inside of the cheeks and gums, accurate discrimination shows that this reference to the parts against which the sapid body is pressed by the tongue, is deceptive, that the real seat of the sense is confined to the tongue itself, and that its immediate organs are the papillæ, and more particularly those denominated *conicæ* or *villosæ*, which are highly vascular and erectile, being observed to rise above the surface of the tongue when any sapid substance is applied to it. On the other hand, no papillæ are discoverable on the palate.

Some substances, such as peppermint, produce a pungent impression on the back of the fauces; and others, again, such as mezereon, excite in the same part a peculiar sense of irritation, which appears to proceed more from a generally acrimonious property, affecting particularly the nervous surfaces, than from any real sapidity; indeed, if the impressions made on the organs of smell be excluded from consideration, it will be found that the extent of the part of the tongue which really receives impressions of taste, is very limited. Mr. Mayo[1] states that salt, aloes, sugar, or acids, which excite the most acute sensation when applied to the tip or edge of the tongue, produce none at the fore or upper part of the organ, or on the hard palate. But at the back of the tongue they again excite sensation enough to be distinguishable, and they are still more perfectly tasted on the middle of the soft palate and uvula. The participation of the soft palate in the sense of taste has been recently pointed out by MM. Guyot and Admyrauld, and has been carefully verified by Mr. Wheatstone and Mr. Mayo. These latter gentlemen did not find that one taste was perceived more distinctly than another, at any point of the tongue or soft palate.

There is no circumstance more remarkable, with relation to this sense, than its intimate connexion with that of smell, of which we are next to speak.

Sect. III.—*Smell.*

Smell.

(616.) The purpose answered by the sense of smell is apparently to guard against the introduction into the lungs of injurious effluvia, as that of taste is to watch over the qualities of the substances introduced into the stomach. Its seat is the Schneiderian membrane lining the cavity of the nostrils; and more particularly the turbinated bones, which are placed so as to catch the odorous effluvia directly as these enter the nostrils, and which, together with the cavities or sinuses in the contiguous bones, contribute to extend considerably the surfaces on which the impression of these effluvia is made.

1. *Organs of Smell.*

Organs of smell.

(617.) The organ of smell may be divided into the *external* and *internal parts*.

The external part, or *nose*, properly so called, consists principally of an upper bony portion commonly called the *bridge of the nose*, composed of the ossa nasi, supported by a vertical process from the æthmoid bone, together with the vomer, and an inferior cartilaginous portion, of which the middle prominence is called the *dorsum;* the rounded portions below are the *alæ nasi*, or wings; and the cartilage forming the partition between the nostrils is termed the *columna nasi.* These cartilages have a degree of elasticity which preserves the form of the organ.

The internal parts are contained in the cavities of the nostrils, which are divided by the *septum narium* into two lateral passages. In the upper part of each nostril, a spongy bone of a lengthened but irregular shape, the *os turbinatum superius*, which belongs to the æthmoid bone. Below this extends the *inferior turbinated bone*, so that the general cavity is divided by these bones into three passages for the air, running from before backwards; they have been respectively named by Haller the *meatus narium superior, medius, and inferior.*

(618.) The extent of the cavities belonging to the nose is much increased by their communicating with various sinuses, or cavities in the neighbouring bones, namely, the *frontal*, *sphenoidal*, and *maxillary sinuses.* Posteriorly the nostrils open into the pharynx, by two orifices, termed the *posterior nares.* All these cavities, together with the sinuses with which they communicate, are lined with a sensible and delicate mucous membrane, termed the *pituitary membrane*, or sometimes, from the anatomist who first accurately described it, the *membrana Schneideriana.* The lower part of the lacrymal sac becoming somewhat narrower, but without forming any valve, passes into the nose, under the name of *lacrymal duct, canalis nasalis*, or *ductus ad nasum.* At the posterior part of the nares is the opening of the Eustachion tube, leading to the tympanic cavity of the ear.

2. *Function of Smell.*

Connex with tas

(619.) The impressions made on the two senses of taste and smell, have not only a great affinity to each other, but also an intimate connexion; inasmuch as many of those referred to the organ of taste are in reality made on the organ of smell, and are not perceived at all if the nostrils be closed, and the odorous effluvia arising from the substance placed on the tongue be consequently prevented from ascending, and acting on the sentient membrane lining their cavity. When the Schneiderian membrane is inflamed, the taste of all those substances, of which the flavour consists in their scent alone, is altogether lost; and as this is the case with by far the greater number of substances employed as food, the sense of taste appears, under these circumstances, to be very imperfect. Both these senses, but particularly that of smell, are possessed by man in a degree very inferior to that in which they exist in the lower animals.

(620.) It is essential to the exercise of this sense, that the membrane of the nostrils should be in a moist state; for when it happens to be dry from a deficiency of secretion, the extremities of the olfactory nerves are unfitted for the reception of the impression of odours. It is also necessary for smelling that the air charged with the odorous effluvia should impinge with some degree of force against the Schneiderian membrane.

The seat of greatest sensibility to odours is the upper part of the nostrils; and the form of the nose and of its apertures are obviously adapted to direct the stream of air towards those parts. It is found, accordingly, that when the nose has been destroyed by disease, the smell is greatly impaired, if not altogether lost.

Classific tion of odours.

(621.) Odours as well as tastes have been attempted to be classed. Linnæus distributed them into seven classes: 1. *ambrosial*, of which the smell of the rose and musk are examples; 2. *fragrant*, as the smell of the lily, of the jasmin, and of saffron; these are more evanescent than the former; 3d. *aromatic*, as the smell of the laurel; 4. *alliaceous*, partaking of the odour of garlic; 5. *fœtid*, exemplified in valerian and mushrooms; 6. *virous*, or narcotic, as in the smell of opium; 7. *nauseous*, as that of the gourd, melon, and cucumber. But this classification is obviously incomplete, as it omits several very distinct classes of odours, such as that of alcohol, of æther, of camphor, of ammonia, of chlorine, &c.

(622.) Any very acrid or stimulating vapour admitted to the nostrils, instead of producing the sensation of smell, gives rise to mere painful irritation, which excites sneezing, and a copious secretion of mucus.

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[1] *Outlines of Human Physiology.*

Sect. IV.—*Hearing.*

1. *Acoustic Principles.*

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(623.) The object of the sense of hearing is to convey to us certain impressions made on the nerves of the ear by the vibrations of the air; which vibrations are the result of some mechanical impulse communicated to it by the motion of a body at a distance. Other media besides air are also capable of transmitting sonorous vibrations to the organ of hearing; thus water is known to convey sounds to great distances; and solid bodies possess the same power in a degree proportioned to their molecular elasticity. If the body which is the source of sound be insulated from any such medium, its vibrations cannot be communicated, and no sound is heard. Thus if a bell be placed in the receiver of an air-pump, in proportion as the air is exhausted the sound it produces when struck becomes more and more faint, till at length, when the rarefaction has been carried a certain length, it is quite inaudible. If the same bell be placed in a vessel of condensed air, the sound it gives out will be louder than in air of the ordinary density.

(624.) The velocity with which sound is transmitted in air of the same density is uniform at all distances, and for all sounds whatsoever. As the air of the atmosphere varies in its density, and also in its degrees of humidity, the velocity of sound is not constantly the same. It may be taken at an average as being 1100 feet in a second, or nearly thirteen miles in a minute.

2. *Organ of Hearing.*

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the ear.

(625.) The organ of hearing is divided into the *external* and the *internal ear.*

(626.) The *external ear*, comprehends the *auricula*, or ear, properly so called, and the *meatus auditorius externus.*

ricula.

(627.) The auricula is chiefly composed of an *elastic cartilage* bent into various folds and hollows, and covered with a thin layer of common integuments, the lower fold of which, enlarged by the addition of cellular substance, forms the depending part called the *lobe of the ear.* The cartilaginous portion is termed the *pinna*, or *ala.* Its outer circle, or prominent margin, is called, from its winding direction, the *helix.* The semicircular ridge within this is the *antihelix;* and the small protuberance, in which the helix appears to terminate below at its inner edge, is called the *tragus,* from its being frequently covered with hair. Another eminence, nearly opposite to this, below the anterior extremity of the antihelix, and projecting outwards over the hollow of the ear, is called the *antitragus.* Between the helix and antihelix, is the cavity called the *scaphus*, or *fossa navicularis.*

atus
itorius.

(628.) The *concha* is a large depression under the antihelix, and divided into two parts by the helix. The lower of these leads to the *meatus auditorius*, a passage which at its commencement is composed of cartilage, and farther on is joined to the orifice of the same name in the temporal bone. The cartilaginous tube is lined by a soft membrane, giving rise to hairs, and containing small glands, the *glandulæ ceruminosæ*, which secrete the wax of the ear. This cartilaginous portion of the ear is attached to the temporal bone by several ligaments and muscles; the effects of which in moving the different parts of the external ear are in general very little sensible.

(629.) The membrane lining the meatus is continued along the osseous portion of the canal, which is closed by the *drum* of the ear, or *membrana tympani.* This is a firm, oval, and almost transparent membrane, fixed in an osseous groove at the bottom of the meatus, across which it lies in an oblique position. It is slightly concave on the external side; and is capable of being stretched or relaxed by the action of particular muscles.

Tympanic
cavity.

(630.) The membrane of the tympanum divides the external from the internal ear. Behind it we find an irregular cavity, called the *tympanic cavity*, or *cavity of the tympanum*, which is filled with air; it is about seven or eight lines wide, and about half that space in breadth; and is every where lined by a fine membrane. It has four openings; the first is the small orifice of a passage of communication with the back of the cavity of the nostrils, which is called the *Eustachian tube*, and is shaped like a trumpet, expanding as it approaches the fauces. The second aperture leads to a number of irregular cells, formed in the mastoid process of the temporal bone, and called the *mastoid cells.* At the back part of the tympanum we find an oval opening, called the *fenestra ovalis*, and below this a round perforation, termed the *fenestra rotunda.* Between these fenestræ, is a bony eminence, called the *promontory.*

Ossicula.

(631.) Within the cavity of the tympanum are contained four small bones, the *ossicula auditus*, placed in a series or chain extending across from the membrana tympani to the fenestra ovalis. The *malleus*, or hammer, is the first of these bones; a long pointed process from which, namely, the *processus brevis*, or handle, is fixed to the membrana tympani. It is articulated by its round head with the next bone, the *incus*, or anvil, which much resembles in its shape a molar tooth, having a body and two unequal crura. With the longest of these processes is articulated the *os orbicularis*, of a rounded figure, and smaller than a grain of mustard seed. It forms the medium of connexion between the incus and the *stapes*, which is the last bone in the series, and is so named from its striking resemblance in form to a stirrup. The base of the stapes is fixed to the margin of the fenestra ovalis, which it accurately closes. The articulations of these minute bones are furnished with capsular ligaments, and all the apparatus of the larger joints; appropriate muscles being also provided for their movements. Between the malleus and the incus, there passes a small nervous cord, which crosses the tympanum, and is accordingly named the *chorda tympani.*

Labyrinth.

(632.) The principal cavity of the organ of hearing is situated still more internally, and from the intricacy of its winding sinuosities it has received the general name of *the labyrinth.* All its cavities and passages are lined with a very delicate periosteum, and filled with a watery fluid, and within them is suspended a pulpy membrane of a similar shape, on which are distributed various nervous filaments presently to be described. This saccular-shaped membrane is termed by Breschet the *membranous labyrinth*, in order to distinguish it from the osseous labyrinth, in which it is contained. It forms one continuous closed sac extending within the vestibule and canals, excepting those of the cochlea; and contains a fluid, perfectly similar to the perilymph, and termed by Blainville, *vitrine auditive*, which, intervening between it and the osseous parietes of the labyrinth, surrounds it on all sides, and prevents its coming in contact with those bones.

The central cavity, in which all these passages meet, is termed the *vestibule;* it is of an oval figure, and is situated nearly in the centre of the os petrosum, and at the inner side of the fenestra ovalis. On the side of the vestibule next to the mastoid process, there are five orifices leading to the three *semicircular canals*, as they are called, or passages formed within the substance of the bone. The extremities of two of these canals unite, and terminate by a common opening; hence there appear in the vestibule only five openings, instead of six. These canals are distinguished by the names of the *superior*, or vertical, the *posterior*, or oblique, and the *exterior*, or horizontal. They each form a curvature of more than three-fourths of a circle, and have an enlargement, termed *ampulla*, or *cavitas elliptica*, at one end, the other extremity being nearly of the same size as the rest of the canal.

(633.) The *cochlea*, which is the third division of the labyrinth, has a conical shape, and is situated at the anterior part of the os petrosum, and at the fore-part of the vestibule, with its base towards the meatus auditorius internus, and its apex in the opposite direction; that is, facing outwards. It contains a double spiral passage, winding round like the shell of a snail. This passage begins by a round hole from the vestibule, and after forming two turns and a half, becomes suddenly smaller on arriving at the apex, where it communicates with a similar tube which takes its rise at the base of the cochlea from the fenestra rotunda, formerly noticed as one of the apertures of the cavity of the tympanum; but which is closed by a membrane. The partition which divides these two winding passages is called the *lamina spiralis*, or *septum scalæ;* for the passages themselves are known by the name of the *scalæ cochleæ;* that which communicates with the vestibule being distinguished as the *scala vestibuli*, and the other, from its connexion with the tympanum, the *scala tympani*. The central bony pillar, around which these turns are made has a horizontal direction, and is called the *modiolus*. It has the shape of a cone, at the apex of which is situated another hollow cone in a reverse position termed the *infundibulum*, which, however, is an imperfect funnel, having a common apex with the modiolus, and its base being covered by the apex of the cochlea, which is called the *cupola*.

(634.) It has been supposed that when the fluid in these cavities is in too great a quantity, the superfluous portion is carried off by two minute canals or *aqueducts*, discovered by *Cotunnius*, and bearing his name. One of these opens into the bottom of the vestibule, and the other into the cochlea, near the fenestra rotunda. They bear the names respectively of *aquæductus vestibuli* and *aquæductus cochleæ*. They both pass through the os petrosum, and communicate with the cavity of the cranium.

The form of that part of the membranous labyrinth which occupies the cavity of the vestibule, and which has accordingly received the name of the *membranous vestibule*, though having a general resemblance to that of the cavity itself, yet differs from it in some degree, being composed of two sacs opening into each other. One of these sacs is termed the *utricle;* and the other the *sacculus*. Each sac contains in its interior a small mass of white calcareous matter resembling powdered chalk, and which seems to be suspended in the fluid contents of the sac by means of a number of nervous filaments, derived from the acoustic nerves, and of which they appear to be the ultimate ramifications.[1]

(635.) Through an opening at the base of the modiolus, a branch of the auditory nerve, which has entered by the meatus auditorius internus, passes into the funnel-shaped cavity, and is thence extended through the spiral canals; while another branch passes backwards through the vestibule, and dividing into several branches, enters the orifices of the semicircular canals. The minute branches perforate a part of the bone, which has been termed from its appearance, the *cribriform plate*.

3. *Function of Hearing.*

Functions of the several parts of the ear.

(636.) We thus see that the ear is an organ extremely complicated in its structure, evidently intended to convey the sonorous undulations of the air, after they are collected by the more external parts of the organ, to the branches of the auditory nerve, which are spread over the membranes lining the different cavities of the labyrinth, and the cretaceous bodies suspended within those membranes. We may therefore distinguish the several parts of the apparatus employed for this purpose, according as they are merely designed to collect the aerial undulations, and increase their intensity by concentrating them into a smaller space; or according as they contain the expanded nerves on which the impression is ultimately made. It appears that the medium by which this last effect is produced, is the perilymph, or fluid filling the cavities of the labyrinth, and containing the exquisitely delicate membrane and cretaceous bodies on which the extreme fibrils of the auditory nerve are expanded. This fluid is put in motion by the air in the cavity of the tympanum, and thrown into corresponding undulations.

(637.) The accessory parts of the organ of hearing may therefore be divided into three parts. There is, first, the external ear, which is an elastic cartilaginous appendage to the organ, curiously grooved, so as to form a series of parabolic curves, adapted to receive the undulations of the air, and convey them into the passage of the meatus externus, serving apparently an office similar to that of the expanded part of a trumpet. The sonorous undulations are thus made to strike against the membrane of the tympanum, or ear-drum, which is stretched across, and closes the passage. The cavity behind this membrane is filled with air, which is next thrown into undulations by the medium of the ear-drum, the vibrations of which have been excited by those of the external air. In order to preserve an equilibrium between the air in the cavity of the tympanum and the external air, so that the membrane may not sustain a greater pressure on one side than on the other, a communication is kept open with the back part of the throat by means of the *Eustachian tube*. Hearing is always much impaired, if from any cause the Eustachian tube is obstructed, as it sometimes is by a common cold, which then produces a temporary deafness.

(638.) The cavity of the tympanum is of a very singular form, extending into the mastoid process of the temporal bone, which has a cellular structure. A chain of minute bones, the ossicula auditus, extends, as we have seen, across the cavity, terminating at the fenestra ovalis, or aperture leading to the vestibule; while another aperture, the fenestra rotunda, also closed by membrane, leads to one of the spiral turns of the cochlea. Thus, the fluid in the labyrinth receives from the impulses made on these two membranes, which are situated in two different planes, a double undulation; and these two undulations, the one circulating along the semicircular canals, the other through the spiral turns of the cochlea, probably unite at some focal spot, like the meeting of two tidal waves, and increase the effect produced. These undulations must of course be variously modified, according to their frequency, and the order of their succession, and the impressions made on the nerve must undergo corresponding modifications. But we are so completely in the dark as to the real office of the several parts of this elaborately constructed organ, that it is exceedingly difficult to prosecute the physiology of this sense with such imperfect data. We are unable even to form a rational conjecture as to the offices of the delicate muscles provided for directing the movements of those ossicula, which are articulated with such great nicety, and which seem calculated to alter the tension of the membrana tympani, and bring it into a state capable of vibrating in unison with the sonorous undulations that impinge upon it. What adds in no small degree to our embarrassment, is the knowledge we have acquired of the power of hearing being retained, without apparent diminution, when the greater part of this apparatus of bones, with their joints and muscles, and even the ear-drum itself, has been destroyed by accident or disease.[2] It should be observed, however, as Mr. Mayo[3] remarks, that the stapes is so strictly applied to the membrane of the fenestra ovalis, that the loss of this bone necessarily produces incurable deafness, by the attendant injury of the labyrinth.

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[1] The most accurate and complete description of the anatomy of the ear, is that given by Breschet, *Sur les Organes de l'Ouie*, which first appeared in the *Annales des Sciences Naturelles*, xxix. 129. A compendious account is contained in *Dr. Roget's Bridgewater Treatise*, ii. 420.

[2] See two papers by Sir Astley Cooper, in the *Philosophical Transactions* for 1800, p. 151; and for 1801, p. 437.

[3] *Outlines of Human Physiology*, 3d edition, p. 221, note.

(639.) Sir Everard Home imagined that the muscular structure of the membrana tympani, enabling it to contract or relax according to circumstances, so as to vibrate in unison with the musical notes which reached the ear, conferred the power of distinguishing musical tones. But this ingenious hypothesis is completely overturned by the fact above stated, of the integrity of the membrane of the tympanum not being necessary for the perfect accuracy of the sense of hearing, even with relation to the distinction of musical sounds. Dr. Young thinks it probable that the semicircular canals which are disposed in a remarkable manner in three orthogonal planes, corresponding to the three dimensions of space, enable us to estimate the acuteness or pitch of a sound; and that the cochlea serves the office of a micrometer of sound.[1] But the grounds of these opinions are too vague and conjectural to inspire us with any confidence in their solidity. When the external passages are totally obstructed, sonorous vibrations may still be transmitted to the auditory nerves by means of the bones of the head. Thus, the sound of a tuning fork applied to the teeth, or even to other parts of the head, is perfectly audible under these circumstances. We thus possess a criterion for determining, in cases of deafness, whether the disease consists in the insensibility of the nerves to these impressions, or is seated in the passages leading to the labyrinth.

SECT. V.—*Vision.*

ision.

(640.) The physiology of the eye is more interesting than that of any of the other organs of the senses; because, from the knowledge we possess of the laws of optics, to which it is so admirably adapted, we can understand the offices of its several parts, and the mode in which they concur in the production of the resulting effect. The study of the eye has been said to be the best cure for atheism; and it furnishes, indeed, the most striking and unequivocal proofs of the existence of design and intelligence in the construction of the animal fabric. These proofs have accordingly been always among those most prominently adduced by philosophers in support of the arguments of natural theology.

(641.) The organs subservient to vision are lodged securely in the bony cavities of the orbits, where the surrounding bones protect them on every side, excepting in front. They may be divided into the internal and the external parts; the former consisting of the spherical bodies denominated the *globes of the eye*, or *eye-balls;* and the latter comprising parts which give motion to the globe, and otherwise assist it in its functions.

1. *Internal parts of the Eye.*

e-ball.

(642.) The eye-ball is composed of segments of two unequal spheres; one of which, constituting about four-fifths of the whole, forms the portion which is within the orbit; while the other fifth is that part which is seen in front, and which, being a portion of a smaller sphere, is more protuberant. The diameter of the eye-ball, from behind forwards, is accordingly longer than its transverse diameter; the proportion being that of twenty-five to twenty-three.

(643.) The eye-ball is made up of coats and humors. The former consist of the *sclerotica*, *cornea*, *choroides*, and *retina*, together with the *conjunctiva*. Of the latter there are three, viz. the *vitreous*, *crystalline*, and *aqueous humors*.

ats.

(644.) The *sclerotica*, which is the exterior coat, is, from its compact fibrous texture, the densest and strongest, as well as the thickest of the tunics of the eye, and the one from which the other parts of the eye-ball derive their principal support. It covers all that portion of the globe of the eye, which has already been pointed out as constituting its largest segment. At its anterior edge it is joined to the more convex tunic, which completes the figure, and is named the *cornea*, from its being composed of a great number of concentric laminæ, of a horny elastic texture. Some authors have given it the name of the *cornea lucida*, from its perfect transparency, and by way of contrast to the sclerotica, which they had named the *cornea opaca*.

(645.) The *choroid coat*, or *tunica choroides*, lies immediately within the sclerotica, and is composed of a congeries of blood-vessels connected together by membrane. It has been distinguished into two layers, the innermost of which has been termed the *tunica Ruyschiana*. At the middle of the choroid coat are observed numerous vessels convoluted into a spiral form. These have been termed the *venæ vorticosæ*. The internal surface of the tunica Ruyschiana, or *tapetum*, as it has been called, seems, from its villous or fleecy appearance, to be a secreting surface. It is everywhere lined with a black or deep-brown mucous substance, included in a fine cellular tissue. This is the *pigmentum nigrum*, which forms a layer, separating the choroides from the next coat, or *retina*. This latter tunic is an expansion of the pulpy substance of the optic nerve, spread over a fine membrane. The optic nerve, from which this medullary matter is derived, enters the eye at its back part, at a point nearer to the nose than the centre, or axis of the eye, and perforates the sclerotic and choroid coats.

(646.) From the inner margin of the junction of the cornea and sclerotica, there extends across the fore part of the globe of the eye a membranous partition, called, from the variety of its colour, the *iris;* it is perforated in the centre by an aperture, called the *pupil*, because, as it is said, it represents objects no larger than a pupilla, or puppet. The structure of the iris is exceedingly peculiar; it appears to be made up of a number of fibres, which pass from the inner to the outer margin in a radiated direction, together with others which run circularly. These fibres have been presumed to be of a muscular structure; but doubts are still entertained with regard to this point. The posterior surface of the iris is lined with a pigment similar to that which is found within the choroid coat. It has been called the *uvea*, from its fancied resemblance in colour to the grape.

(647.) The iris is connected with the choroid coat by an intermediate structure, called the *ciliary ligament*, *ciliary circle*, or *orbiculus ciliaris*, which is a circular belt, more than a line in breadth, made up of a soft and pulpy tissue, and of a whitish colour. It is also at this part that the choroides adheres firmly to the sclerotica. From this part, also, there extends inwards a dark coloured ring, which is a continuation of the choroides, and is termed the *corpus ciliare*. It is about the sixth part of an inch in breadth towards the temple, but somewhat narrower towards the nose. It is covered in every part by the pigmentum nigrum. It is marked by radiated striæ at its inner part, but they are somewhat obscured by the pigmentum nigrum. At the outer part these striæ become gradually broader and more elevated, and appear like folds, only the intervals between them being covered with the pigment. These folds are termed the *ciliary processes*. Each of these processes is of an irregular triangular figure, with the base outwards, or at the ciliary circle, and its apex inwards, or towards the axis of the eye. Their number is generally about sixty, and they are alternately longer and shorter.

Humors.

(648.) About three-fourths of the globe of the eye, within these several tunics, is filled by a very transparent and gelatinous humor, which, from its supposed resemblance to melted glass, has been termed the *vitreous humor*. It is nearly of the consistence of the white of an egg, and consists of a fluid substance contained in the cells of a very fine and delicate cellular tissue, called the hyaloid membrane. It is invested by a transparent membrane, termed the *tunica vitrea*, or *capsule* of the vitreous humor. The anterior surface of the vitreous humour is depressed, for the lodgment of the *crystalline lens*, or *humor*, which is a dense body, perfectly transparent, and has the shape of a double convex lens, of which the posterior surface has a greater convexity than the anterior surface. The lens is composed of a great number of concentric laminæ, which become more and more dense towards the centre, and each lamina is made up of very distinct parallel fibres. It is enclosed in its own peculiar *capsule*, in which it appears to float loosely, a watery fluid, called the *liquor Morgagni*, being interposed.

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[1] *Medical Literature*, p. 98; and *Lectures*, vol. i. p. 387.

(649.) The fore part of the eye-ball, between the crystalline lens and the cornea, is filled by a watery fluid, called the *aqueous humor*, in the middle of which the iris is suspended, thus dividing the space into what are called the *anterior* and *posterior chambers* of the aqueous humor. The aqueous humor, like the other humors, is contained within a delicate membrane, which lines the inside of the cornea, and passes over the crystalline lens and the convex margin of the vitreous humor.

(650.) The capsule of the lens adheres closely to the tunica vitrea. Behind the edge of the former, and between the margin of the ciliary zone and capsule of the vitreous humor, a triangular passage is formed, called from its discoverer, the *circle of Petit*, or *canalis Petitianus*. When air is blown into this passage, it passes freely round the edge of the lens.

(651.) At that part of the retina which is situated in the axis of the eye, there is a small circle, where the retina is transparent, giving rise to the appearance of a hole, as if the retina were deficient in that part. It was discovered by Soemmerring, and bears the name of the *foramen centrale of Soemmerring*. It is surrounded by a yellow circle, about a line in diameter. The fibres of the optic nerve, in passing to form the retina, perforate a thin plate of membrane which is extended from the sclerotica, and which is termed the *lamina cribrosa*. The centre of the optic nerve is perforated by the *arteria centralis retinæ*, forming an aperture which has been called the *porus opticus*.

2. *External parts of the Eye.*

Appendages to the eye-ball.

(652.) The orbit is a conical cavity, in the fore part of which the globe of the eye is situated, the remaining space behind the globe being chiefly filled with fat, which surrounds the optic nerve, and intervenes between it and the straight muscles that extend between the margin of the foramen opticum, through which the optic nerve passes out of the skull and the fore part of the sclerotic coat, where they are inserted by broad and flat tendons. These tendinous expansions have been improperly considered as composing one of the tunics of the eye, which being of a white colour, has received the name of *tunica albuginea*.

(653.) The globe of the eye is covered at the fore part by two eye-lids, or *palpebræ*, which are composed of muscular fibres, covered by the common integuments, supported at their edge by a cartilage called the *tarsus*, and furnished with a row of hairs, termed *cilia*, or eye-lashes. At the roots of the eye-lashes are sebaceous follicles, named from the anatomist who first observed them, the *glandulæ Meibomii*, and which secrete a glutinous liniment. The eye-lids are lined on their interior surface by a very fine and smooth serous membrane, which is reflected over the anterior part of the globe of the eye, and even over the surface of the cornea. This membrane is called the *tunica conjunctiva*.

Lacrymal apparatus.

(654.) Between the ball of the eye and the upper vault of the orbit, on the temporal side, lies the *lacrymal gland*, which secretes the tears. It is composed of a number of small, whitish, granular bodies, which are collected together into two lobes. There is also a chain of smaller glands lying between the principal gland and upper eye-lid, and connecting them together. The excretory ducts from all these glands are exceedingly minute, and terminate in the inner surface of the upper eye-lid, near the outer angle of the eye. After moistening the surface of the eye, the tears are again collected by two small orifices, called the *puncta lacrymalia*, placed on a small eminence in each eye-lid, near the inner angle of the eye, at the extremity of the tarsus. They are the beginnings of two small canals that run in the direction of the edges of the eye-lids, towards the side of the nose, where they approach each other, and terminate together in the *lacrymal sac*, which is a membranous bag situated on the os unguis, and leading to a passage into the cavity of the nostrils. The puncta are kept separate by the interposition of a small reddish body, called the *caruncula lacrymalis*, situated between the inner angle of the eye-lids and the ball of the eye. Minute hairs are found upon the surface of this body, which serve to entangle small objects which might otherwise get into the eye. There is also a reduplication of the tunica conjunctiva, shaped like a crescent, and hence termed the *valvula semilunaris*, the points of which are directed towards the puncta, and which assists the caruncle in directing the tears to the puncta.

Having thus described the apparatus for vision, we shall now proceed to consider the mode in which that function is performed.

3. *Optical Principles.*

Laws of light.

(655.) The object of this sense is to convey to us a knowledge of the existence and visible qualities of distant objects, by means of the light which they send to the eye. This is accomplished by altering the natural direct course of these rays, so that they may form a distinct image of these objects on the retina. That such images are actually formed on the retina may be easily shewn in the eye of an animal recently killed, by carefully removing the opaque sclerotic and choroid coats, together with the black pigment from the back of the eye, so as to expose the retina. The objects on the other side, in front of the cornea, will then be seen beautifully depicted on the retina, their images being inverted; precisely in the same way, and on the same principles as they are seen in a simple camera obscura.

(656.) In order to understand and trace the operation of the principles concerned in these phenomena, it will be necessary to refer to the laws of optics.

Refracti

The rays of light in traversing any medium of uniform density, move always in straight lines; but when the density changes they deviate somewhat from this rectilinear course, according to the direction of the ray with respect to the planes in which the change of density occurs. Thus a ray from the sun, or other celestial body, traversing obliquely through our atmosphere, the different strata of which are of increasing density as they come nearer to the earth, is gradually bent in its course, and arrives at the surface of the earth in a direction somewhat nearer to a perpendicular line than if there had been no atmosphere. This deflexion from a straight line is termed *refraction*. Refraction takes place suddenly, if the ray passes abruptly from one medium to another, which sensibly differs from it in its density; the direction of the deflexion being always towards the denser medium; or, to speak more accurately, towards a line drawn perpendicular to the surface common to the two media, and situated in the denser medium.

Reflexio

(657.) In the case of the passage of a ray through the surface of a new medium of very different density from the first, another phenomenon takes place; the ray is decomposed, part being transmitted and refracted, while another portion is turned completely back into the medium it was already traversing. This is termed *reflexion*. Objects which are not luminous in their own nature are rendered visible only by the reflexion from their surfaces of the light which they receive from other bodies. The law in this case is, that the angle of reflexion, by which is meant the angle which the course of the reflected ray makes with a line perpendicular to the surface, is equal to the angle of incidence, or the angle which the incident ray makes with that same perpendicular; and also, that it is in the same plane with the incident ray, and the perpendicular line.

(658.) The law of refraction is, that the course of the refracted ray is deflected towards that part of the perpendicular which is situated in the denser medium, and that the sine of the angle of refraction, (or the angle it makes with the perpendicular) has to the sine of the angle of incidence the same constant ratio. This ratio increases in proportion to the difference there is between the two media in respect of density.

4. *Formation of Images in the Eye.*

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images.

(659.) It follows as a consequence of the above laws, that a pencil of rays proceeding through the air, and falling on the convex spherical surface of a medium of greater density than the air, (as is the case with the cornea of the eye,) is so refracted as to be collected, after proceeding a certain distance, into one and the same point. This will readily appear when we consider that those rays fall with more obliquity on the cornea, according as they are more distant from the central ray of the pencil, or that which may be conceived to fall perpendicularly on its surface. These more oblique rays are consequently more refracted; that is, more bent from their original course; and this law being observed throughout the whole pencil, all the rays will tend after refraction to the same point, which point is called the *focus* of that pencil of rays.

(660.) The same process taking place with regard to all the other pencils of rays proceeding respectively from the several points of the objects viewed, and each being collected into separate points in different parts of the retina which receives them, images of those objects will be delineated on that membrane; for it is evident that all the focal points will have, with respect to one another, the same relative positions as the points of the external objects from which each pencil of rays proceeds, when referred to the sphere of vision. The impression thus made on each respective point of the retina, is transmitted to the sensorium, where it makes a distinct impression, and gives rise to the sensation of light and colour; and in conjunction with the experience gradually gathered from the sense of touch, imparts to us a knowledge of the existence, relative situation, form, magnitude, distance, and colour of the objects before us. This, then, is vision.

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ts.

(661.) Such is the general outline of the mode in which vision is accomplished; but there are a thousand beautiful contrivances and adjustments provided for ensuring the accuracy with which this picture of the surrounding scene is portrayed on the retina. The perfection of vision is entirely dependent on the distinctness, the vividness, and the fidelity of this picture; and the whole apparatus of the eye is calculated to obtain these qualities.

(662.) The purposes served by the apparatus external to the globe of the eye, are sufficiently obvious. The effectual protection given to the eye by the arched form of the bones which compose the orbit,—the provision of a soft cushion in the fat which occupies the bottom of the cavity,—the beautiful contrivance of the eye-lids, which, on the least appearance of danger, are ever ready to close upon the organs they are appointed to guard,—and even the direction of the eyebrows, intended to divert the course of the perspiration from the forehead, are all calculated to call forth our admiration, because the end to be answered being obvious, we can judge of the fitness of the means for the accomplishment of those ends. A still further proof of exquisite design offers itself in the lacrymal apparatus, which provides the means of preserving the surface of the cornea always clean and transparent, and fitted for its office of regularly refracting the rays of light.

Function
of the iris.

(663.) The humors of the eye, through which the light passes before arriving at the retina, have different degrees of density, and consequently have different degrees of refractive power. The first and greatest refraction of the rays takes place at the outer surface of the cornea; the next is at the inner surface, where the rays meet with the aqueous humor. Now this humor is rather less dense than the cornea, and consequently the rays already refracted, and rendered convergent by the cornea, have their convergence slightly diminished, when they traverse the aqueous humor. These, in fact, are converging towards points at some distance beyond the retina. The iris is interposed in the course of the rays while they are passing through the aqueous humor; the circular aperture of this membrane, the pupil, admitting only the more central portion of each pencil of rays. By intercepting the extreme rays, which, in consequence of a peculiarity in the law of spherical refraction, hereafter to be explained, would, if allowed to reach the retina, somewhat confuse the image, greater clearness of that image is obtained, at the sacrifice, indeed, of a portion of brightness. It serves, accordingly, the same purpose with regard to the eye, which the circular ring, placed in the interior of a telescope, effects in contracting the aperture of the instrument; rendering the image more distinct, though less illuminated than it would otherwise be. But the iris has this great superiority over the circle in the telescope, inasmuch as it is capable by its contractile power of enlarging or diminishing the aperture of the pupil, as occasion requires. Thus, when the object viewed is but faintly illuminated, the pupil is enlarged, and admits more light, thus giving greater brightness to the picture; an advantage which more than compensates for the slight indistinctness of the fainter images composing that picture. When, on the contrary, an object is too bright, so that its image would produce too vivid an impression on the retina, the pupil immediately contracts, so as to reduce the quantity of light admitted into the interior of the eye, and to prevent any injurious effect upon the retina.

5. *Adjustments for the Correction of Aberration.*

Aberration
of sphericity.

(664.) That part of the converging pencil of rays, which is admitted through the pupil, falls upon the anterior convex surface of the crystalline lens, which being denser than the aqueous humor, occasions a new refraction of the rays, and gives them an increased degree of convergence, so that they now tend to foci nearer to the retina than before, though still somewhat beyond it.

(665.) An exquisite provision is found in the peculiar structure of the lens for correcting what is termed the *spherical aberration.* It is a necessary consequence of the mathematical law of refraction, that in a pencil of rays falling on the convex spherical surface of a denser medium, those rays which are farthest from the central ray, will be bent somewhat more than is requisite to bring them to the same focal point as the rays which are nearer to the centre of the pencil; hence all the rays can never be collected accurately into the same point; although in ordinary optical instruments, such as common telescopes, and camera obscura, the aberration thus resulting is confined within such narrow limits as not to produce any very great inconvenience. But in the eye even this minute defect of ordinary optical instruments is remedied. The lens is composed of successive laminæ, increasing in their density and refractive power, in proportion as they approach the centre; that central part being the hardest and densest of the whole. The central rays of each pencil, therefore, are subjected to a greater refractive action than the more exterior rays, and the whole are brought accurately to convergence at the same focal point.

(666.) After passing through the crystalline lens, the rays enter the vitreous humor, where, again, there is a change of density in the medium. The density of the vitreous humor is less than that of the lens; and were its surface convex, the convergence of the rays would be diminished by the refraction they would then experience; but the surface being concave, the refraction contributes still farther to increase the convergence of the rays, which now traverse the aqueous humor, and are collected accuratcly into their respective foci on the retina itself.

Aberration of parallax.

(667.) Rays proceeding from objects at different distances from the eye, will arrive at the cornea with different degrees of divergence, and the same refractive powers of the humors would cause them to converge at different distances; in order, therefore, to obtain distinct images of these objects on the retina, either the distance of that membrane from the cornea must be altered, or the refractive power of the humors must be changed. Thus, if the power of the eye at any one time be suited to distinct vision of distant objects, near objects will appear confused, from the indistinctness of their images on the retina; because the focus of convergence of the rays proceeding from those objects is farther back than the situation of the retina. If, either by elongating the axis of the eyc, the retina could be removed to this new focal distance, or else by increasing the refractive power of the humors, the rays could be made more convergent than before, we should again obtain distinct images of those near objects on the retina; but then the images of distant objects would, at the same time, and from the contrary cause, be indistinct; and in order to give distinctness to these, the contrary changes are required to be made in the eye to those already mentioned. Now, it is found that the eye really possesses the power of accommodation here described, adapting itself, by some internal changes, to the vision of both near and remote objects, according as the attention is directed respectively either to the one or to the other.

(668.) The effort by which the eye changes its intcrnal state, so as to accommodate its powers to the vision of near objects, after having viewed those more distant, is always attended with a contraction of the pupil; and the exclusion of the remoter rays, consequent upon this diminution of aperture, must partly contribute to the greater distinctness of the images, by excluding the rays near the circumference of each pencil. But it is certain that the refractive powers of the eye are also increased; and it is a question of considerable difficulty to determine the manner in which this increase is effected. Sir Everard Home[1] supposed that it was accomplished by the joint actions of the straight muscles which surround the ball of the eye, and which, by compressing it all round its sides, might elongate its axis and increase the distance of the retina from the cornea, while they at the same time would make the cornea more convex, by drawing back its circumference, and thus rendering its central part more protuberant. This plausible theory is overturned by the fact discovered by Dr. Young,[2] that when the effect of any change in the curvature of the cornea is removed by placing the eye under water, the eye still retains its power of accommodation to the vision of objects at different distances, by changes which take place in its refractive powers.

(669.) The most probable supposition relative to this operation is, that the ciliary ligament has the power of contracting at the same time with the sphincter of the iris; a change which will be attended with the effect of bringing the lens somewhat forwards, and of increasing the convexity of its surfaces, while the convexity of the cornea will also be increased. Any cause which produces the contraction of the pupil, such as a bright light, enables the eye to adjust itself more rapidly to vision at a shorter distance; and on the contrary, the suspension of this power of contraction of the circular fibres of the iris, occasioned by belladonna, is accompanied by the total but temporary loss of this power of adjustment. Those who, by frequent practice in experimenting on their own eyes, have acquired a considerable voluntary power of changing the refracting condition of the eye, even although there be no object before the field of vision requiring such change, when they exert this power, also contract the pupil, which by this means indirectly acquires the character of a voluntary muscle; although in other respects, and with other persons, it is strictly to be ranked in the class of the involuntary muscles. The writer of this treatise possesses this power, and has given an account of the circumstances attending its exertion in a letter to Mr. Travers.[3]

Chrom aberrat

(670.) The same gradation of density in the successive laminæ of the crystalline lens, and the consequent successive refractions of the rays effected by the several humors of the eye, have also the effect of correcting the dispersion of light, arising from the difference in refrangibility of the differently coloured rays. The eye, in addition to its other perfections, has the properties of an achromatic optical instrument, correcting the confusion of colour in the images it forms on the retina.

(671.) All extraneous light, which might be reflected from one part of the eye to another, and might be mixed with the rays which should exclusively form the image on the retina, is absorbed by means of the *pigmentum nigrum*, which is placed immediately behind the retina, which lines every part of the interior of the eye, and which extends over the ciliary circle, and over the posterior surface of the iris.

(672.) Different parts of the retina possess different degrees of sensibility; the centre, or that situated in the axis of the eye as it is called, immediately oppositc to the pupil, being by far the most sensible part. We accordingly see most distinctly those objects, the images of which are formed on that spot. Hence, whenever we pay attention to an object, we immediately direct both eyes towards it in such a manner as that the centre of both retinæ may receivc its image. It is very remarkable that there is a minute circular space situated exactly in the axis of the eye, where the retina seems to be deficient, so as to produce the appearance of a perforation at the very point where vision is most distinct. No satisfactory explanation of this curious circumstance has yet been given.

(673.) When the eye is at rest, the field of distinct vision is very limited; it extends, however, according to Dr. Young, to a space formed by a radius of about 60 or 70 degrees; it extends to a greater distance outwards than inwards, being 90 degrees in the former direction, and only 60 degrees in the latter. It extends downwards 70 degrees, and only 50 degrees upwards.

Insensi spot in retina.

(674.) Mariottc[4] of the French Academy of Sciences, made the curious discovery that there is a part of the retina situated at the termination of thc optic nerve which is insensible to light; so that when the image of any object falls upon that precise spot, it is no longer seen. The conclusion which he drew from this fact was, that the scat of vision is not the retina, but the choroid coat; for at this spot the choroid coat is wanting, being perforated to admit of the passage of the optic nerve. But the phenomena is better accounted for by the consideration that there is present at that spot the central artery of the retina, which here divides itself into a number of radiating branches, and excludes the presence of nervous matter, in which, judging from the analogy of all the other senses, the power of communicating sensation exclusively resides. This defect in vision, if we may so term it, is seldom perceived when both eyes are used, because the optic nerve enters each eye obliquely, and on different sides of the centre of the retina; so that they can never both receive the image of the same object at the same time.

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[1] See *Philosophical Transactions* for 1794, p. 21; 1795, p. 1; 1796, p. 1; 1797, p. 1.

[2] *Ibid.* for 1793, p. 169; and for 1801, p. 53.

[3] Contained in the sketch of the Physiology of the Eye, prefixed to Mr. Travers' *Synopsis of the Diseases of the Eye and their Treatment*, p. 72.

[4] *Phil Trans.* for 1668, vol. iii. No. 35, p. 668; and also *Mémoires de l'Acad.* i. 68, and 102.

yopia and esbyopia.

(675.) The defects of the eyes of some persons with respect to their refractive powers produce what is called *long-sightedness*, when these powers are deficient; and *short-sightedness*, when too great. The source of former imperfection, which constitutes the *presbyopic eye*, may often be traced to the effects of age, which produces a flattening of the cornea; and probably also impairs that voluntary power by which the refractions may be increased when near objects are viewed. The short-sighted, or *myopic* eye, has generally an excessive convexity of the cornea, which may be diminished, but is very seldom materially so, by the progress of age. The remedies for these defects are obvious; namely, the use of convex spectacles for the presbyopic, and of concave spectacles for the myopic eye; the former supplying the deficiency in the power of refraction; the latter correcting its excess.

(676.) Such then are the means employed for producing certain impressions on each retina, which it is the office of the optic nerves to transmit to the sensorium, where these give rise to corresponding sensations. The inquiry into the perceptions arising in the mind in consequence of these sensations belongs to another branch of the subject hereafter to be considered. It will be sufficient in this place to point out the general fact relating to the physiology of the eye, that the impression made upon each point of the retina, produces in the sensorium a distinct impression, suggesting to the mind a distinct sensation.

CHAP. XV.—PHYSIOLOGICAL LAWS OF SENSATION.

Sect. I.—*Phenomena of Sensation.*

(677.) Having examined the different modes in which impressions are made upon the extremities of the nerves situated in the respective organs of sense, we have next to direct our attention to the physiological phenomena which ensue on those impressions being received.

1. *Specific Endowments of the Nerves of Sensation.*

cificen- ments erves.

(678.) The extremities of the nerves intended to receive these impressions appear in general to be expanded over a certain extent of surface, and to be of a softer texture than the nerves themselves. This difference appears to arise from their being divested of the membranous covering which closely binds together the filaments composing the nerves, while they are pursuing their course from one part to another. Such expansions are noticed in the optic, auditory, and olfactory nerves, and probably also in those distributed to the papillæ of the tongue, and the cutis. The nerve of each particular sense appears to have different specific endowments. Thus the optic nerve and retina are peculiarly adapted to be affected by the impressions of light; and are not fitted to convey any other impressions. There are experiments recorded which tend to shew that irritation of these nerves do not communicate pain, as is the case with that of nerves sent to other parts of the body. On the other hand no other nerve in the body is capable of exciting, by any change that can be induced upon it, the sensation of light, as was pretended in the case in the celebrated imposture of Miss M'Avoy of Liverpool, who endeavoured to persuade people that she could see with the tips of her fingers: or in the more elaborate delusions of animal magnetism, in which persons are stated to be able to read a piece of writing applied to the pit of the stomach, or nape of the neck, by optical impressions made on different parts of the skin.[1]

(679.) That the optic nerves are incapable of exciting by their action any other sensations than those of light, is farther rendered probable by the circumstance that these sensations may be produced by other causes than those which usually give rise to them; such as impressions of a mechanical nature. A blow in the eye, producing sudden pressure on the retina, excites the sensation of a flash of light. The appearance of brilliant spangles in the field of vision is often the result of too active a state of circulation in the vessels of the retina, which excites in the fibres of the nerves actions similar to those produced by the presence of light. The galvanic influence affecting the same, or even neighbouring nerves, produces, in like manner, the sensation of a flash of light. Analogous facts have been noticed with regard to other senses. The well-known sensations of singing in the ears is the consequence of an action of the auditory nerves, excited by the state of the circulation in the organ of hearing, and is probably totally unconnected with any real sonorous vibrations communicated to that organ.

2. *Modifications of Impressions.*

Duration of impressions.

(680.) In order that an impression made upon the sentient extremity of a nerve may excite sensation, it must be applied for a certain time; for if it be of too transient a duration, no effect, as far as regards sensation, is produced. This is well exemplified in the case of vision; we lose sight of an object in very rapid motion, because the impression made by its image on the different points of the retina on which it is successively formed, is of too transient a nature to excite those actions which produce sensation.

Visual illusions.

(681.) On the other hand, when a distinct impression has been made on the nerve, that impression has a certain duration, independently of the continuance of the cause which excited it; for the sensation produced is, to a certain extent, permanent. This is also shewn, in the case of vision, by several experiments familiar to all, such as whirling rapidly with a circular motion, an object brightly illuminated, which gives rise, as is well known, to the appearance of a continuous circle of light. Many optical deceptions are founded on the same principle, such as that of the *Thaumatrope*, of the *Phantascope*, or *Phenikisticope*, and the curved appearance of the spokes of a revolving wheel when viewed through parallel bars, of which last phenomena the theory has been elsewhere given by the writer of this treatise;[2] and also the appearance of a similar kind noticed by Mr. Faraday.[3]

Coalescences of impressions.

(682.) One of the consequences of the law of the permanence of sensations is, that impressions which rapidly succeed one another in the same nerve, are not distinguishable as separate impressions, but produce a blending together, or coalescence into one sensation. Thus if a circle painted in different parts of the circumference with different colours, be rapidly whirled round its centre, the colours are blended together into one tint; and if the different prismatic colours of the spectrum be properly adjusted as to their relative proportions, the effect of this coalescence of the sensations excited by the whole is that of a white colour. The thaumatrope may also be made to illustrate this principle; for the pictures on the two sides of the card appear, by the rapid revolution of the card, to coalesce into one.

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[1] See Magnetism, Animal.

[2] *Philosophical Transactions for* 1815.

[3] *Journal of the Royal Institution*, vol. i. p. 205. See also Dr. Roget's *Bridgewater Treatise*, vol. ii. p. 524.

(683.) The most remarkable and complete illustration of the same principle is afforded by musical sounds, which, though they appear continuous, are, in fact, composed of separate impulses, repeated at very short, but regular intervals of time.

Modifications of sensibility by previous impressions.

(684.) Another law of sensation, is that when a nerve has received a strong impression, that nerve is proportionally weakened for a certain time after, and is less susceptible of a similar impression from the application of the same cause. The eye, after being dazzled by a strong light, has its sensibility diminished to the impressions of a weaker light. Different parts of the retina thus acquire different degrees of susceptibility of being affected by the same quantities of light. Thus, if the eyes be directed steadily to a bright object for a certain length of time, and be then transferred to a white sheet of paper, a dark spot, having the figure of that object will be seen on the paper, in consequence of that portion of the retina, on which the luminous image had been impressed, being fatigued, and rendered less excitable than those parts of the retina which did not receive that image. The light from the paper which arrives at that part of the retina which had received the impressions of the bright object, will produce less effect on that part, than the light of equal intensity from other parts of the paper does on the other parts of the retina. Those parts of the paper which are situated so as to have their image on the exhausted part of the retina appear darker, therefore, than the rest; and hence arises the appearance of a dark image. The experiment may be reversed by fixing the eyes attentively for some time on a dark object on a white ground, and then transferring it to some other part of the white ground; when immediately a brighter spot, corresponding in size and figure to the dark object, will be seen.

Ocular spectra.

(685.) These appearances, which imitate those of real objects, have been called *ocular spectra*. The susceptibility of the retina to receive impressions of particular colours is also found to be affected in the same manner, when any one of them has been strongly impressed. Thus the spectrum of a coloured object, while it has the same dimensions and figures as the object, will at the same time have an opposite colour, when the eye is transferred to a white ground. It will have what is called the *complementary colour* to that of the object itself; that is, it will have that tint which results from the admixture of all the colours composing white light, when the latter colour is left out. Thus red and green, yellow and purple, blue and orange, being complementary colours respectively to each other, the ocular spectrum of a red object will be green, that of a green object red, and so with all the others.[1]

(686.) We may here observe, that the appearances of spectra above described, are merely temporary; for the several parts of the retina soon regain their natural state of equable sensibility.

(687.) Illustrations of this law readily present themselves when we search for its application with regard to all the other senses. Sounds which are too loud produce temporary deafness, or at least impair for a time the sensibility of the ear to weaker sounds. Similar phenomena are observed as to odours and tastes, with reference to their appropriate senses. The sensibility of the skin to different temperatures varies considerably according to the previous impressions which have been made upon it. Thus the same body may appear either hot or cold, according to the previous temperature of the hand which is applied to it.

SECT. II.—*Conditions necessary for Sensation.*

Conditions for sensation.

(688.) The sensibility of the sentient extremities of nerves, or their capability of receiving such impressions as lead to their appropriate sensations, is dependent on certain conditions of the organ. These conditions are principally the following. First, it is necessary that the organ receive a proper supply of arterial blood by the vessels circulating through it, and particularly through that part on which the nerves are distributed. Secondly, it is required that the expansion of the nerve belonging to the organ should be exempt from excessive pressure. Compression of a nerve in any part of its course immediately puts a stop to all its functions; and consequently its power of receiving and conveying impressions is suspended as long as the pressure is continued. On the removal of the pressure, provided it has not been too violent, or too long continued, the nerve after a certain time, generally recovers its powers. Thirdly, a certain temperature is requisite for the maintenance of sensibility in the nerves. The benumbing effect of cold is well known, and extends generally to all the functions of the nervous system. It is very probable that this operation of cold is referable to its retarding or arresting the circulation in the capillary vessels; and it might, therefore, perhaps, be included in the causes which influence the first of the conditions here enumerated. Lastly, the office of every nerve being to transmit impressions from one of their extremities to the other, it is necessary for the due performance of this function, that an uninterrupted continuity of their filaments should be preserved throughout their whole course. The complete division of a nerve in any part, necessarily prevents this transmission, and destroys the function of the nerve.

(689.) Irritations applied to the nerve in any part of its course, produce sensation, provided the communication of that part with the brain be uninterrupted by any of the causes above specified. Thus, if a nerve be tied or divided at any point, irritations applied below the ligature or division will produce no effect as to sensation; but when applied above that point, sensation immediately follows. What is here said applies more particularly to the nerves distributed to various parts of the body, and especially to the integuments; the irritation of which nerves gives rise to a sense of pain. The nerves of the senses of sight, of hearing, of smell, and of taste, are so situated as hardly to admit of being the subjects of experiments which might decide the question as to what kinds of sensation would be excited by irritations directly applied to them; and whether these sensations would be similar to those they usually convey from impressions made upon their extremities. Analogy would undoubtedly be in favour of such similarity. Persons who have lost a limb by amputation, experience sensations not only of pain, but also of touch, and of muscular motion, exactly similar to those which they formerly derived from the parts of the limb which they have lost. These sensations arise from imitations taking place, either in the lower extremities of the nerves which have been divided, and which remain in the stump, or in the brain itself.

(690.) The most remarkable circumstance attending the communication of irritations along the nerves of sensation, is the celerity of the transmission. It appears, indeed, to be instantaneous, and can be compared only to the rapidity of the electric fluid passing along a conducting body.

SECT. III.—*Theories of Sensation.*

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(691.) We are completely ignorant of the nature of that power by which the nerves effect this rapid communication along the lines of their fibres, and even of the changes which take place in the nerve while it is performing this function. Several hypotheses have been proposed with a view to supply this chasm in our knowledge. The oldest of these, and that which maintained its ground for many centuries, is, that the brain and nerves are furnished with a certain fluid, which was called the *animal spirits*, and was the medium of communication between the different parts of the nervous system. Traces of this theory may be found in the writings of Hippocrates; but it derived its principal support from Descartes, who reduced it to a regular form, and powerfully recommended it by the force of his authority. According to the views of those who espouse this theory, the brain is considered as an organ whose principal office it is to secrete the animal spirits, which are of a very subtile and ethereal nature, and to supply them to the nerves, which were considered to be the natural excretory ducts of the brain. The existence of this fluid was, for a very long period, universally admitted by physiologists, and the doctrines founded upon it were more or less mixed up with all the reasonings of physicians respecting the causes and phenomena of diseases, and the effects of remedies. Traces of the influence of this doctrine may be found in the popular language of medicine even in the present day, when the hypothesis from which it is derived is deservedly exploded as perfectly gratuitous, and devoid of any just foundation.

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[1] For more ample details on this subject, the reader may be referred to an Essay on Ocular Spectra, by Dr. Charles Darwin, published in the 76th volume of the *Philosophical Transactions*, and reprinted in Dr. Darwin's *Zoonomia*.

pothesis ibra- s.

(692.) Another hypothesis invented to account for the propagation of impressions along the fibres of nerves, was that of their depending on vibrations or periodical oscillations of their particles, analogous to those of the strings of a harpsichord when producing musical notes. The great champion of this doctrine was Hartley,[1] who embellished it by his beautiful applications to a great variety of phenomena relating to sensations, and even to the intellectual operations. It afforded a happy explanation of many of the phenomena of ocular spectra, and of those depending on the permanence of sensations. It is needless to remark, that this hypothesis is equally visionary and destitute of any solid basis as the former.

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(693.) All these mechanical theories are overturned by the fact that no tabular structure can be discovered, on the minutest anatomical scrutiny, to exist in the filaments which compose the nerves; nor can the slightest motion be detected in any of their parts, while they are actively transmitting the impressions of sensation.

(694.) The latest hypothesis as to the nature of nervous power is, that it is identical with electricity. It is supported principally by the experiments we have already mentioned, in which, after the par vagum was divided, so as entirely to intercept its action in promoting the secretion of the gastric fluid, secretion was restored by transmitting the galvanic fluid along the lower portion of the nerve. The experiment, indeed, applies only to a particular office of the nervous power, namely, that of promoting secretion; but the hypothesis it suggested has been extended to all the other functions of the nerves, and of course to their power of transmitting those impressions which give rise to sensation.

CHAP. XVI.—FUNCTIONS OF THE SENSORIUM.

SECT. I.—*Locality of the Sensorium.*

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(695.) If we except the nerves appropriated to the organs of the special senses of sight, hearing, smell, and taste, and those distributed on the face, and other neighbouring parts, all the nerves subservient to sensation appear to terminate in the spinal cord. We are then, in the first place, to determine whether the impressions which these nerves convey to that organ, are transmitted to any other part of the nervous system, previously to sensation being produced.

(696.) Experiments in all the animals whose structure, as far as regards this part of the nervous system, is analogous to the human, have established the general fact, that sensation does not take place, unless the part of the spinal cord to which the nerve is connected, communicates by an uninterrupted continuity of substance with the brain. The division of the spinal cord near the foramen magnum, instantly renders the whole body insensible; but it does not appear so immediately to deprive the parts about the face of sensibility, for some degree of it appears to be retained as long as the circulation continues. The injury, indeed, soon becomes fatal, by the circulation ceasing in consequence of the interruption to the function of respiration. The effects of injuries to the spinal cord occurring to men from accidents of various kinds, afford ample confirmation of the fact that the brain is the general centre to which all impressions made upon the nerves must ultimately be brought before they can excite sensation.

(697.) Admitting the brain to be the immediate organ of sensation, it next becomes a question, whether any particular part of the brain is more especially appropriated to the exercise of this function. It is to such a part, supposing it to exist, that the name of *sensorium* has been applied. There are two modes of conducting this inquiry; the first is by tracing very carefully, the filaments of all the nerves which are immediately connected with the brain, and endeavouring to discover if they unite in any central part of that organ, which may accordingly be supposed to be the seat of sensation; or, in other words, the sensorium. The second mode of investigating the subject, is to ascertain if any one part of the brain can be discovered, on which impressions directly made, are invariably productive of sensation.

(698.) The fibrous substance of the spinal cord, being directly continuous with the medulla oblongata, may be supposed to terminate in that part of the brain; so that, viewing the spinal cord as a collection of all the fibres of the nerves of sensation continued along its whole length, these nerves themselves may be considered as following this course, and having this termination. These fibres are found more particularly to converge towards the corpora quadrigemina, and crura cerebri. Now, it happens that this is also the very spot with which the nerves of the senses, whose organs are in the head, namely, the fifth, seventh, and eighth pairs, are more particularly connected. It appears also, from the late investigations of the French physiologists, that no part of the brain higher than the corpora quadrigemina, and no part whatever of the cerebellum, is essentially concerned in sensation; for it is found that in animals the power of sensation remains, even after the removal of all the parts of the brain, or of the cerebellum, higher than this spot. The conclusion which has been deduced from these experiments is, that the medulla oblongata, and more particularly that segment of it to which the nerves of the head are united, is the organ most essentially connected with the mental change constituting sensation. But it is not probable that these corporeal changes immediately connected with sensation, are confined to a *single point* in the brain, which might emphatically be termed *the seat of the soul*, as Descartes expressed it, when he boldly pronounced the pineal gland to be that spot.

SECT. II.—*Requisite conditions of the Sensorium.*

Conditions of the sensorium.

(699.) A multitude of facts tend to confirm the view of the subject which has here been taken. The same conditions as those which are required for the exercise of the functions of the nerves in every part of their course, are equally necessary for the performance of those of the brain. It is indispensable that the circulation in the brain should be in a healthy state, and that arterial blood be supplied by its vessels. It is indispensable that a proper temperature be preserved; and it is likewise indispensable that the brain be not compressed by any considerable force. A failure in any one of these conditions, produces total deprivation of the power of sensation, as well as of all the other functions of the brain. This effect is found to result more particularly when pressure is made in the direction of the medulla oblongata; for in that case complete insensibility takes place; and on the removal of the pressure, the faculty of sensation slowly returns; but if any considerable injury has been inflicted on that part, the power of sensation is irrecoverably lost.

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[1] *On Man.* A full account of Hartley's theory is given by Dr. Priestley in a separate work bearing that title.

(700.) It is probable that most of the laws which regulate the functions of the nerves with respect to sensation, apply with equal truth to the sensorium itself; but with regard to several of the phenomena, it is difficult to determine whether they depend on affections of the sensorium, or of the extremities of the nerves, situated in the organ of sense. We must despair of being able to resolve this question, because the changes which take place in both these parts, appear to be simultaneous. The impaired power, for example, which is the result of a strong impression from an object of sense, may arise equally from the exhaustion of that part of the sensorium to which the impression is communicated, as of that of the sentient extremity of the nerve; and we have no means of discriminating between them.

(701.) Another point of resemblance is, that irritations applied to the sensorium, from other sources than the nerves themselves, give rise to the same train of sensations as impressions communicated through the nerves. These irritations may be given by the pressure of blood circulating in the arteries of the sensorium; and this is probably the source of many of those sensations generally ascribed to affections of the nerves, or of the organs of sense. Pains, and other sensations in various parts of the body, arise from affections of the brain. The same origin may often be assigned to sensations which arise in dreams, and likewise to various spectral illusions which affect persons who are awake, and aware of their being deceptions of the sense. In delirium and insanity, the sensations from this cause assume a fearful degree of intensity, and are accompanied by a fixed belief in their reality.

Sect. III.—*Laws of Recurrence, and of the Association of Impressions.*

Law of recurrence.

(702.) With regard to all the subsequent changes and operations which take place when sensation has been excited, it is extremely difficult to pronounce how much of the phenomena are purely mental, and how much are strictly the result of corporeal changes connected and associated together by physical laws. In other words, it is difficult to determine what are the operations in which the mind is purely passive, and dependent on the actions of its bodily organs, and what are those in which it exerts a spontaneous power of action, and thereby reacts upon those organs, and produces in them a series of changes which lead to the most important results. The distinction we are attempting to draw, is founded upon this essential difference in the order of sequence of the phenomena, that in the one the organic change precedes the mental change, and in the other succeeds to it.

Law of spontaneous recurrence.

(703.) The two principal physiological laws relating to the former of these physical changes, namely, those which precede the mental affections, are, first, the *law of spontaneous recurrence.* Whenever an impression of a certain intensity has been made upon the organs of sense, the sensation which is produced by it, after disappearing for a certain time, recurs without the presence of the cause which originally excited it; and this happens repeatedly, and without any corresponding effort of the mind, and often in opposition to any effort which can be made to counteract the tendency. This spontaneous recurrence of sensations is probably the result of the repetition of those changes in the sensorium which originally gave rise to them. In the language of metaphysics, the corresponding mental affections are termed *ideas*, in order to distinguish them from the similar and more vivid affection excited by the primitive impression, and to which the term *sensation* is more particularly appropriated.

Law of association.

(704.) The second law which regulates the unknown affections of the brain connected with the passive phenomena of mind, is that of *association*, or the law by which impressions, and consequently the corresponding ideas, recur in the same order of sequence as that in which they were originally excited. The phenomena of disease, and the operation of different agents which modify the state of circulation in the brain, and the conditions of the nervous powers, afford ample evidence that the modes of association, and of the sequence of impressions and ideas, are dependent on the physical condition of the brain, and result from certain changes taking place in that organ.

(705.) The views here presented, far from being favourable to the doctrine of materialism, are directly opposed to it; since they necessarily imply the existence of an essential distinction between mind and matter, and aim only at tracing the connexions which have been established between them by the divine Author of our existence.

(706.) Such, then, being the physiological connexions which exist between the physical changes taking place in the brain, and the passive phenomena of the mind, it is not an unreasonable supposition, that the voluminous mass of cerebral substance which, in the human brain especially, has been superadded to the medulla oblongata, or to the immediate physical seat of sensation, is in some way subservient to that astonishing range of intellect and combination of mental faculties which are found in man. We may conjecture also, with much appearance of probability, that in the lower animals, the intellectual endowments which mark several of the more intelligent races are connected with similar, though inferior, expansions of cerebral substance.

(707.) All the mental phenomena in which the mind is passive have been referred by metaphysicians to the principle of association, and consequently may, in as far as this principle is concerned, be connected with the physical changes above noticed. Hence we find the memory, which is the direct result of that law, is more especially liable to be impaired by certain physical states of the brain, such as those induced by severe concussion, by fevers, and by the progress of age.

(708.) As scarcely any thing is known with regard to the physical changes which take place in the brain in the relations which they bear to mental phenomena, the further consideration of these phenomena belongs properly to psychology rather than to the subject of this treatise. The inquiry must here be taken up by the metaphysician, whose province it becomes not the physiologist to invade.

Sect. IV.—*Volition and Voluntary Motion.*

Phenomena consequent on volition.

(709.) Leaving, therefore, to the metaphysician the analysis of those mental phenomena, which, however dependent they may be for their existence on the healthy actions of the brain, require modes of investigation different from those of physiology, and lead to results very remote from any conceivable laws of material agency; we may resume the subject at the point when, in consequence of the mental acts of *volition*, by which term we here mean to express the endeavour to produce certain specific movements of the body, new changes are again produced in the cerebral organs, and new trains of physical phenomena succeed. That this mental effort of volition constitutes a distinct step in the series of phenomena, is proved by the instances of paralysis, in which the patient is conscious of making the effort to move the palsied limb, yet no motion, or even sensation of motion, ensues. Another illustration of the same distinction is derivable from a different disease affecting the limbs, namely, *anæsthesia*, which consists of the loss of sensation only, while the power of voluntary motion remains; and in which the voluntary act so exerted produces the intended muscular contractions, unattended, however, with the feelings which usually accompany them. The same complete ignorance in which we are with regard to the changes which take place in sensation, pervades our notions of those which attend volition, in as far as they occur in the brain. A few facts, indeed, have been collected with regard to those parts of the brain which are impressed, if such a term may be used, antecedently to the voluntary motions of the limbs. They appear to be chiefly the crura of the cerebellum, and the adjacent parts of the medulla oblongata.

(710.) All the physical conditions which are necessary in order that sensations may be felt, are equally necessary for rendering the cerebral organs capable of receiving from the mind those impressions which lead to voluntary motion. The mental stimulus of volition produces a certain effect on the origin of the nerves, leading to the muscles employed in these motions, which impression, being propagated along the course of those nerves, excites these muscles to contraction. The transmission of those impressions is made with the same celerity, and probably by the same agency, as those which produce sensation; but they are made in the contrary direction, namely, *from* the brain, instead of *towards* it. The same conditions of perfect continuity of fibres, of freedom from pressure, and of healthy circulation, are essential requisites in both cases; and every thing that has been said with regard to the former, is also applicable to the latter. Mechanical irritations, applied either at those parts of the brain which adjoin the origin of the nerves, or to the nerves themselves, either at their origin, or in any part of their course, whether that portion of the nerve situated between the point to which the irritation is applied be entire or divided, or compressed by a ligature, are found to produce the same muscular contractions as those which are the result of volition.

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(711.) Mr. Mayo[1] ascertained, that after any nerve which supplies a voluntary muscle is cut through, either in a living animal, or immediately after death, mechanical irritation of the part of the nerve disconnected with the brain, as for instance the pinching it with a forceps, causes a single sudden action of the muscle or muscles it supplies. On the other hand, a like effect cannot be produced by irritating mechanically the nerves distributed to those muscles over which the will has indisputably no influence. "It must be admitted, however," he remarks, "that this phenomenon is not exclusively confined to those muscles which are allowed on all hands to be voluntary; nor, indeed, is it shewn in all the muscles which seem at first sight to be directly under the controul of the will." But it is not easy, in various instances, to determine whether muscular actions are voluntary or not; while the point of distinction proposed by Mr. Mayo has the recommendation of being easily verifiable. Setting aside, therefore, in the first instance, the question of the influence of the will, let us be satisfied with observing what muscles act when a divided nerve that enters their substance is mechanically irritated, and what do not. We may afterwards trace the collateral differences of the two classes of muscles which are thus distinguished.

(712.) The parts which are susceptible of this mode of excitement, are the muscles of the trunk, head, and limbs, of the tongue, of the soft palate, of the larynx, of the pharynx, and œsophagus, and of the lower outlet of the pelvis. The opposite class comprehends the heart, the stomach, the small and great intestines, and the bladder.

(713.) The collateral differences which characterize either class are, with exceptions afterwards to be adverted to, the following:—

Of the muscles which act when a nerve distributed through them is mechanically irritated, it may be remarked:

1. That they admit of being thrown into action by an effort of the will.

2. That with sufficient attention and resolution, their action may be refrained from.

3. That their action is attended with a conscious effort, and is guided by sensation.

4. That if divided, the separate parts retract instantaneously to a certain distance, and subsequently undergo no farther permanent shortening.

5. That when mechanically irritated, a single and momentary action of their fibres alone ensues.

6. That they remain relaxed, unless excited by special impressions, both in the living body, and before the loss of irritability after death.

7. That their action in the living body habitually results from an influence transmitted from the brain or spinal cord through the nerves.

(714.) The exceptions to be made against this statement, if applied generally, are, that the three first affections are not easily brought home to the muscular fibres of the œsophagus, or of the lower part of the pharynx; but it deserves at the same time to be considered, that the lower part of the pharynx and the œsophagus are in the peculiar situation of parts employed on one object alone, instinctively and habitually, on the recurrence of one impression; a condition which would soon reduce a strictly voluntary muscle to a state apparently removed from the control of the will.

(715.) Muscles of the preceding class, if we except the fasciculi belonging to the pharynx, and œsophagus, and urethra, are so disposed as to extend from one piece to another of the solid frame-work of the body; they enlarge or straighten the cavities of the trunk; they produce the phenomena of the voice; they close the excretory passages; the greater number are employed to move the limbs on the trunk and the frame on the ground. Muscles of the second class are used, like the exceptions in the preceding, as tunics to the hollow viscera, the cavities of which they diminish in their action, and thus serve to give motion to their contents. The œsophagus, indeed, appears to partake of the nature of both classes of muscles; when the nervi vagi are pinched, one sudden action ensues in its fibres, and presently after a second of a slower character may be observed to take place.

(716.) Of the muscles which do not act on the mechanical irritation of any nerve distributed through them, it may be remarked,

1. That the will cannot instantaneously or directly produce action in them.

2. That the resolution to abstain from their action is insufficient to repress it.

3. That their action is not attended with a conscious effort, and seldom has reference to sensation.

4. That if divided, the retraction which follows is in most instances slow and gradual.

5. That if they are mechanically irritated, not one, but a series of actions ensues.

6. That their natural state, in the absence of external impressions, is not continued relaxation. When the heart and bowels are removed from the body of an animal immediately after death, they continue for a time alternately to contract and to dilate.

7. That an impression transmitted through the nerves does not appear the usual stimulus to their action.

(717.) From the experiments of the French physiologists it would appear, that in an animal deprived of all the upper portions of the brain, but in which the medulla oblongata is preserved, all indications of the more complex operations of thought disappear, but the animal still remains capable of executing such voluntary motions as are of an instinctive character, as, for example, swallowing. Animals deprived of the cerebellum, provided the medulla oblongata remains, and is free from compression, not only appear to be capable of sensation, but give all the usual indications of intelligence, and evidently exert volitions, which occasion the action of many voluntary muscles. But they have lost the power of regulating the contractions of those muscles so as to execute any definite voluntary action, excepting those which are instinctive. All the other voluntary movements of the body and limbs are performed in so irregular a manner, that they are generally ineffective for the purposes for which they are intended; and most of the usual complex movements required for progressive motion cannot be performed at all. This has been explained by the supposition that the animal has lost all recollection or association of those trains of muscular sensations which used to accompany and to guide these movements, in consequence of the loss of the cerebral organs which are instrumental in furnishing those associations. One of the inferences drawn from these facts (which themselves require more ample confirmation before they can be regarded as established) is, that the recollection of those associations connected with voluntary motion depends on the cerebellum, in the same way in which the associations of sensations and ideas depend on the hemispheres of the brain.

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[1] *Outlines of Human Physiology*, third edition, p. 39 to 42.

Decussation of nerves.

(718.) It is a remarkable circumstance that injuries or diseases occurring in the hemispheres either of the cerebrum or cerebellum produce paralysis, that is, destroy the power of voluntary motion, of the muscles situated on the opposite side of the body. This has been endeavoured to be explained by the alleged decussation or crossing of the nervous fibres of the lower part of the corpora pyramidalia on each side. But in order to account for all the phenomena of this kind, we must suppose the decussation to take place between the fibres which compose the posterior and the anterior columns of the spinal cord.

Nerves of sense and of motion.

(719.) Although the function of the nerves in transmitting impressions from the organs of sense to the brain, which give rise to sensation, and in transmitting impressions of volition from the brain to the muscles of voluntary motion, which give rise to the contraction of those muscles, appear to be of the same kind, and to differ only in the direction in which the impression is transmitted, the question has often been asked, whether the same nervous filaments which transmit the one class of impressions are employed to transmit the other likewise; or whether different portions of the nerve are appropriated to these different offices. The truth of the last of these propositions may now be considered as being firmly established.

(720.) The observations which first suggested the idea of there being two sets of nervous filaments, the one subservient to sensation, and the other to volition, were those in which a limb was only partially paralysed, the power of motion being retained, while that of feeling was lost. Experiments had also been made in which nerves that had been divided, and had afterwards spontaneously united, were found to have recovered the power of placing the muscles to which they were distributed under the command of the will, but yet had no power of conveying sensitive impressions. Erasistratus and Herophilus had long ago taught the doctrine of there being two species of nerves respectively appropriated to these opposite functions; and Galen was inclined to the same opinion from observing that both the tongue and the eye are supplied with two separate sets of nerves, the one apparently subservient to sensation, the other to motion. But it is to Sir Charles Bell and to Magendie that the merit belongs of bringing forward decisive proofs of the reality of this distinction between nerves for sensation and nerves for motion, the idea having before been only loosely thrown out by speculative physiologists as a plausible conjecture.

(721.) It results from this discovery that the transmission of impressions in opposite directions, that is, in the one case from the extremities to the brain, and in the other from the brain to the muscles, is effected by different nerves, or at least by different sets of nervous filaments, and that no filament is capable of transmitting impressions both ways indiscriminately, but always in one particular direction. These two kinds of filaments are, it is true, conjoined together into one nerve; but the object of this union is not community of function, but convenience of distribution, the two kinds of filaments still remaining distinct in their functions as they are likewise distinct in their origins. We know that all the nerves connected with the spinal cord have a double origin; that is, are composed of two nerves, the one proceeding from the anterior, and the other from the posterior columns of the spinal cord. It is found that an injury done to the anterior roots of those nerves excites convulsions in the muscles which they supply, but does not appear to excite any sensation of pain in the animal on which the experiment is made; and the division of those nerves is followed by the immediate paralysis of those muscles, that is, by their incapability of being excited to contract by any voluntary efforts. On the contrary, the irritation of the posterior roots of the same nerve is attended with no contractions of muscles, but calls forth expressions of violent pain. The section of these nerves is followed by insensibility of the parts which those nerves supply, while the power of voluntary muscular contraction remains.

Symmetr cal system of nerves.

(722.) From the symmetrical situation of these nerves with regard to the spinal cord, Sir Charles Bell has given them the name of the *original*, or *symmetrical nerves.* They comprehend, of course, all the spinal nerves which arise by double roots, the posterior of which has invariably a ganglion near its origin, while the anterior branch has no such appendage. These spinal nerves are distributed laterally to the two halves of the body; those of the one side having no connexion with those of the other. Sir Charles Bell ranks the fifth pair of the cranial nerves in the same class as the spinal nerves; considering its two roots as composed of filaments, appropriated the one to sensation, the other to motion; the former being provided with a ganglion near its origin, and the latter having no ganglion. He regards the third, probably the fourth, the anterior branch of the fifth, the sixth, the portio dura of the seventh, and the ninth, as being exclusively motor nerves, distributed to the muscles of the eye-ball, lower jaw, face, and tongue, and placing these muscles under the control of the will. The ganglionic portion of the fifth pair, on the other hand, he regards as the great sentient nerve of the head; which gives exclusively sensibility to the face, eye-ball, mucous membrane of the nose, mouth, and tongue. This nerve is in communication with the posterior column of the spinal cord; whilst the motor nerves, above enumerated, appear to communicate with the anterior column. An exception to this rule, however, occurs in the case of the fourth pair, which has never been proved to communicate with the anterior column of the spinal cord. It would appear also that the larger portions of the eighth pair, which seem to be more connected with the posterior than with the anterior columns, are nerves both of sensation and of motion; so that the exclusive appropriation of the nervous filaments, originating from the different surfaces of the spinal cord, to motion or to sensation, is perhaps not yet rigidly demonstrated.

(723.) It is remarkable that the peculiar sensations conveyed by the optic, the olfactory, and the auditory nerves, have been found by Magendie to be much impaired, or even entirely lost, by injuring the branches of the fifth pair of nerves, which also supply the respective organs to which the above nerves appear to be particularly appropriated. The cause of this anomaly has not yet been satisfactorily explained.

piratory ves.

(724.) Sir Charles Bell has distinguished another class of nerves, which he conceives to be altogether subservient to the function of respiration, and to be distributed to the muscles concerned in that function. These he terms the *irregular*, or the *superadded*, or the *respiratory nerves*. They arise by single roots; they pass from one organ to another in various directions, and pursue a very irregular and intricate course, passing across the nerves belonging to the symmetric system, occasionally uniting with them, and connecting together the two halves of the body. These nerves, according to Sir Charles Bell, are not under the control of the will, and are not capable of exciting sensations; their only office being that of transmitting impressions from one part to the other. The nerves which strictly belong to this class are the eighth pair, the spinial accessory nerves, the phrenic, the external respiratory nerve of Sir Charles Bell, and the great sympathetics.

(725.) The first pair, or the olfactory nerves, the second, or the optic, and the portio mollis of the seventh pair, are wholly nerves of sensation; and from the special nature of the impression they convey, may be considered as forming a separate class of nerves.

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(726.) Most nerves pass through *ganglia*, or are interwoven with others in *plexuses* before they reach their destination. The purposes answered by this intermixture of filaments, which, in either case, appears to take place, is to provide extensive connexions between the parts supplied with nerves and different portions of the spinal cord, or medulla oblongata, from which the several fibres originate. Thus the sensative and the motory filaments are intimately united in the same nervous cord, which is thus rendered capable of performing all the functions of nerves. Many hypothetical uses have been assigned to the ganglia, which appear to be unsupported by facts. Drs. Gall and Spurzheim suppose that they contribute to increase the nervous power in those nerves on which they are placed; but there does not seem to be any solid foundation for this opinion.

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(727.) Muscular contractions, then, may be distinguished, with reference to the nervous power which excites them, into four classes; namely, 1. The purely voluntary motions; 2. The automatic motions; 3. The instinctive motions; 4. The involuntary motions. We have now fully considered the first of these classes, the purely voluntary motions, which may be defined to be those consequent on an effort of volition of which the mind is conscious, and which is accompanied by a distinct idea of the end intended to be accomplished. No examples or illustrations are necessary of motions belonging to this class, as they are those with which we are most familiar. We pass on then to the other classes in the order in which we have enumerated them.

Sect. V.—*Automatic Motions.*

tomatic ions.

(728.) Automatic motions are those which consist of a series of actions, each of which was originally the object of a distinct volition; but which by habit, that is, by repeated association, have become linked together in such a manner, that a simple act of volition is sufficient, apparently, to renew the whole series, without requiring any separate effort of attention to each. Most of the actions which we daily perform, such as walking, speaking, writing, or playing upon a musical instrument, afford examples of automatic motions, being linked together by associations which, far from requiring any conscious acts of volition, follow one another in a regular order of sequence that cannot be broken unless by the exertion of a separate effort of atttention. All these movements, however, are still voluntary, inasmuch as they remain under the control of the will, which commands their commencement, can regulate their course, and can stop them at pleasure.

(729.) The muscular actions required for respiration may probably be classed under this head. The immediate exciting cause of the act of inspiration is a sensation felt in the chest from the presence of venous blood in the capillary vessels of the lungs; and this sensation, if not speedily relieved, increases rapidly to one of extreme distress, and even agony. The influence of this sensation in exciting the very complicated actions which are necessary to relieve it by drawing air into the lungs, and which, indeed, are continued during sleep, and even when sensibility to all other impressions appear suspended, as in the state of apoplexy, is rendered manifest by the increased frequency and energy with which these actions are performed whenever any cause exists obstructing the free acces of air into the lungs, and thus augmenting the intensity of the sensation.

(730.) Since the actions of respiration are caused, in the first instance, by sensations, they must be dependent on the sentient nerves of the lungs, and especially on those that establish the most direct communication between them and the medulla oblongata, namely, the eighth pair of nerves. We find, accordingly, that after the section of those nerves the actions of respiration are performed more slowly and less perfectly than when entire. They, nevertheless, continue, probably by means of the other communications which the lungs have with the brain, through the branches of the great sympathetic proceeding from the spinal cord. When the part of the medulla oblongata from which these nerves originate is injured, all attempts at inspiration are finally arrested, because a final stop is put to the sensation which prompts them. The section of the phrenic nerves, or an injury to the spinal cord at any part above the origin of those nerves, paralyses all the respiratory movements of the chest, and thus occasions asphyxia and sudden death.

(731.) When the sensation which prompts inspiration, is intense and long continued, all the muscles performing movements auxiliary to this act, such as those which assist the intercostals in elevating the ribs, which hold the glottis open, which raise the velum pendulum, which open the mouth, and which expand the nostrils, are called into simultaneous action, and the movements themselves are performed in concert, and with perfect precision. These actions are under the control of the will, as respects their force, their rapidity, and their frequency, and they may even be performed at pleasure, either separately or in conjunction; unless, indeed, the sensation which prompts them be unusually intense; in which case they cease to be voluntary and automatic, and pass into the class of instinctive motions we are next to describe. Sir Charles Bell supposes that the nerves of all the muscles employed in these auxiliary actions have peculiar connexions among themselves at their origin from the lateral columns of the spinal cord, from which the eighth pair, which is the great sentient nerve of the lungs, also arises; and that these connexions are the principal cause of their conjunction of action, whenever the sensation imperiously demands that they should act in concert. Yet, on other occasions, we find that all the muscles concerned in these actions, are strictly voluntary muscles, and are perfectly obedient to the will.

Sect. VI.—*Instinctive Motions.*

Instinctive motions.

(732.) It is the essential character of motions which are strictly voluntary, that they are accompanied not only by a consciousness of their being performed, but also by a conviction that we may, or may not perform them, as we please; or, to speak more philosophically, according as there exists or not, a sufficient *motive* for their performance. But there are also, in the healthy state, many muscles, of the actions of which we are always conscious, and which, under ordinary circumstances, are perfectly obedient to the will, but whose actions we have, on other occasions, no direct power of controlling by any effort of the will. They occasionally seem even to be rebellious to its authority, and as if they were transferred to the agency of some other power. They are always preceded by some sensation, as in the case of coughing, sneezing, and vomiting; or some internal affection of the mind, which has been termed *emotion*, as in the case of laughing and weeping; and they take place without any previous conception of the object they are calculated to attain, and therefore without the previous existence or operation of a motive. A very large proportion of the actions of brute animals appear to belong to this class; being characterized by the absence of that train of mental operations, which imply the agency of motives, and the previous knowledge of the consequences resulting from such actions; operations which are comprehended under the term *reason*, as contradistinguished from *instinct*, or blind and inexplicable impulse derived from other sources.

(733.) Instinctive motions are distinguished by Dr. Alison into two kinds, the one comprising such as are not only prompted by an act of which we are conscious, but are also directed without our being aware of it at the time, to an end which we desire; the other, those in which our actions are consequent indeed on a sensation, but are prompted by a blind impulse, the consequences which are to flow from the action being either unknown or disregarded; as, for instance, in gratifying the appetites, guarding the eyes from danger by closing the eyelids, or the body from falling by throwing out the hands. Dr. Alison, in his *Outlines of Physiology*, to which we are indebted for several of the preceding remarks and illustrations, has very clearly treated of the whole subject of the functions relating to muscular motion. He farther remarks that the instinctive actions are closely connected with the motions which proceed directly from sensations on the one hand, and with the strictly voluntary motions on the other. In the adult human being, it is hardly possible to distinguish them from movements which have been prompted by reason, and become habitual; but in the infant, and in the lower animals, they are easily recognised, being distinguishable by two marks; first, that they are always performed in the very same way; whereas actions which are strictly voluntary, and prompted by reason, although directed to the same ends, vary considerably in different individuals; and, secondly, that, however complicated the movements may be, the truly instinctive actions are performed equally well the first time as the last; whereas even the simplest of the strictly voluntary movements require education. The complex acts of sucking and deglutition performed by a new-born infant, may be given as examples of strictly instinctive motions.

(734.) It is important, however, in the consideration of this subject, that we bear in mind, that these actions, although in themselves instinctive, are yet performed by muscles which are at other times voluntary, and whose nervous connexions with the sensorium, render it necessary for the performance of these actions, that the muscles themselves should communicate by their respective nerves with the sensorium. We may fairly presume, therefore, that such actions are immediately dependent on a change taking place in the sensorium, through the medium of which alone the impression which is the occasion of the actions, becomes effective in their production.

Sympathetic actions.

(735.) The same remark applies also to those sensations which arise from *sympathy*, as it is termed; that is, which are referred to a part of the body very different to that to which the actual irritation is applied. Of this kind is the pain of the shoulder accompanying inflammation of the liver; pain of the knee from disease of the hip-joint; and itching of the nose from irritations in the bowels. These sympathetic sensations may perhaps be explained by the nerves of those corresponding parts having their origins from the same parts of the brain; but much yet remains to be done towards establishing the truth of this hypothesis.

Sect. VII.—*Involuntary Motions.*

(736.) Under the head of the involuntary motions, we mean to comprehend all those muscular contractions which are performed without the intervention of any change in the sensorium, and consequently without being attended with either sensation, consciousness, or any other mental change. The most unequivocal examples of this class of motions are those in which muscular actions are excited by irritations applied directly to the motor nerves which are sent to the muscles themselves; for although, in the living body, such irritations are usually accompanied with the sensation of pain, that sensation must be regarded as an accidental concomitant, and not a necessary part of the phenomenon; as is proved by the absence of all sensation, when the nerve has been divided between the brain and the part to which the irritation is applied, and yet the muscles in which the nerve terminates, exhibit the same involuntary contractions as before. The same phenomenon, indeed, may be reproduced after the death of the animal, or when the brain or head has been removed.

(737.) Other cases are met with of a more complex and dubious character; namely, those in which muscles usually under the influence of the will, exhibit contractions in consequence of irritations applied, not to their own nerves, but to some more distant part, which receives other nerves. It is manifest that in these instances, the irritation of these latter nerves produces an impression which is propagated along their course towards the central parts of the nervous system, and is from thence again transmitted along the course of the nerves supplying the muscles, in which they excite contractions of the same kind as those originating in volition. Yet these motions may take place wholly independently of the sensorium, and are found to occur, indeed, when all communication with the brain is intercepted. For if, a few seconds after an animal has been deprived of life, the spinal cord be divided in the middle of the neck, and also in the middle of the back, upon irritating either by a mechanical or chemical stimulus, or by the application of heat, any sensitive portion of the body connected by nerves with either of these isolated segments, the muscles of that portion of the limb, so connected with the spine, are thrown into action. If, for instance, the sole of the foot be pricked, the foot is suddenly retracted, with the same gesture as it would have been during life, and of course with the same apparent indication of suffering.[1] It is evident that here an irritation applied to a nerve, the usual office of which during life was to transmit impressions to the sensorium productive of sensations of pain, has now produced an impression which is conveyed to the spinal cord only; but which yet is followed by the contractions of those very same muscles, which, during life, obeyed the determinations of the will, and produced a motion of the limb directed to its removal from the cause of injury.

(738.) Phenomena of this description may be observed more readily, and are exhibited in a manner still more marked, according as the animal on which the experiment is made, occupies a lower place in the scale. Among vertebrated animals, the motions just described, and others of a similar character, indicative of sensation and volition, are most easily produced in reptiles, as in the turtle, the serpent, and the frog; in which we find that isolated portions of the spinal cord perform functions analogous to those of the brain, as far as relates to the receiving of impressions from a certain set of nervous filaments, and the transmit-

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[1] See *Mayo's Outlines of Human Physiology*, p. 231.

ting of impressions to other nervous filaments, which proceed from the same part of the spinal cord, and are distributed to the muscles. These two sets of nerves correspond in their functions to the sensory and motor nerves by which sensorial phenomena are produced, (see § 721.) In articulated animals, whose spinal cord consists of a series of nodules of nervous matter, resembling ganglia, connected by two longitudinal cords, and severally giving origin to their respective bundles of nerves, which radiate on each side from these ganglia, as from so many centres, the capability of each ganglion to perform this double function is still more susceptible of demonstration; and each segment of a worm or an insect, for example, appears, in consequence, to enjoy a separate life, and exhibits the semblance of possessing powers of sensation and voluntary motion independently of the rest.

(739.) The question now arises whether these indications of sensorial powers actually proceed from the exercise of those faculties; that is, whether they are accompanied by actual feeling and actual volition, of both of which consciousness is the essence; or whether they exist in appearance only, and without any real consciousness on the part of the individual percipient being. This question, taken in all its generality, it is extremely difficult, perhaps impossible, to decide; and its solution involves that of another problem, equally obscure, which is presently to come under our notice: namely, as to the locality and extent of the sensorium in all the classes of the animal kingdom. The plan of structure, and the vital constitution of articulated animals, are so different from what occurs in the system of animals of the vertebrate type, that whatever may be the conclusions we may form with regard to the sensorial powers and the organs which exercise them in the former class, we are not warranted in extending the same conclusions to the latter class of beings, in all of which we cannot fail to recognise the most decided character of individuality. It is hardly possible to conceive the co-existence of two separate centres of sensation and volition in any vertebrate animal, because we find it impossible to understand how consciousness can be subdivided into portions corresponding to the different segments into which the spinal cord may be divided. If, therefore, we regard the sensorium as occupying any portion of the brain, or rather of the encephalon, such as the medulla oblongata, we cannot admit the existence of a separate or accessary sensorium, situate in any part of the spinal cord, and capable of exercising the sensorial functions independently, when all nervous communication with the principal sensorium is cut off. If the power of sensation could ever be retained, even for a second, after the head has been severed from the body, we must suppose that the seat of that faculty is still in the head, and not in the trunk, the movements of which, when excited by galvanism, however they may resemble those which were performed during life in obedience to volition, in conformity to the design, and prompted by motives arising from bodily sensations, must be regarded as purely mechanical, or rather as the result of mere nervous irritation, and without the existence of either sensation or volition of any kind. We have decisive proofs that in the human system phenomena of this kind occur without any participation of the mind, that is, without either sensation, perception, or volition, in cases where, from accident, the spinal cord has been divided or compressed in the neck, or back, and where the muscles of the trunk that receive their nerves from that part of the spinal cord, which is situated below the injury, are affected with involuntary movements. We are therefore fairly entitled to extend the analogy to other animals whose construction does not materially differ from that of man, however appearances may seem to countenance the hypothesis of the sensibility of the trunk, after its communication with the brain has been intercepted.

(740.) Great confusion has been introduced into this subject by the inaccurate language employed by physiologists in theorizing on these phenomena; and in using which language they have lost sight of the essential distinction which should ever be kept in view between psychological and physical phenomena. The term *sensibility* should be strictly confined to such properties as are immediately connected with the mental changes which are denominated sensations, and which are characterized by attendant consciousness: all other corporeal properties or phenomena which do not produce these mental changes, are simply of a physical nature, and belong to another class to which the same appellation ought never to be applied. Bichat has committed this great error in employing the term *organic sensibility* to denote phenomena of this latter kind; and the introduction of this term has led to an interminable confusion of ideas among those who have adopted his system, and who have been thereby led, from this misapplication of terms, to some vague notion of a peculiar but obscure kind of actual sensation, which they attributed to portions of the nervous system unconnected with the sensorium, independent of all percipience, and partaking of the mystical doctrines of Stahl and Von Helmont as to the operations of their supposed *anima* and *archæus*. (See § 101.)

For the dissipation of these clouds which have too long obscured the ideas and perplexed the reasonings of physiologists, we need only direct on the subject the searching light of philosophical analysis, which will render its outlines clear and distinct, and enable us to follow their various flexures and crossings, and obtain more correct views of the landscape in all its details.

(741.) The power exercised in the instances we have described by the central parts of the nervous system, independently of all sensorial phenomena, is that power which we have already distinguished by the term *nervous power*, in contradistinction to the *sensorial power* exercised by the same system. (See § 96, 536, 537.) To Dr. Wilson Philip belongs the merit of having first clearly pointed out the distinction between these two orders of functions, and of having given them specific appellations. Dr. Marshal Hall has lately introduced a new term, that of *reflex function*, to designate the series of phenomena consisting of the transmission of impressions by certain nerves to the central parts of the nervous system, (which he limits to the spinal cord,) and the consequent transmission of an action by the muscular nerves, which is followed by the contractions of muscles. To the whole system concerned in this function he gives the name of the *excito-motory system;* the nerves receiving the impression he calls the *incident* nerves; and those conveying it to the muscles, the *reflex nerves.*

(742.) It would appear from what has been already noticed, (§ 711,) that every muscle the action of which is capable of being brought under the dominion of the will, and which is therefore entitled to be classed among the voluntary muscles, may occasionally be made to act by other causes, applied either directly to their own fibres, to the nerves distributed to them, or to other parts connected with them only by the medium of portions of the brain, spinal cord, or the ganglia of the sympathetic: and it has been conjectured that the sets of nervous fibrils which are instrumental in the performance of these latter functions, are different from those which are employed to transmit the impressions of sensation and volition. This latter view is the one adopted by Dr. W. Philip, who observes that, " however blended the organs of the sensorial and nervous powers may appear to be, we are assured that they are distinct organs by the fact, that while the organs of the nervous power evidently reside equally in the brain and spinal marrow, those of the sensorial power appear to be almost wholly in man, and chiefly in all the more perfect animals, confined to the former."[1] It does not, however, appear that we as yet possess any direct means of either establishing or disproving the truth of this supposition.

Involuntary motion.

(743.) There yet exists another class of muscles, comprehending those which never, under any circumstances, become voluntary. To this class belong the heart and blood-vessels; the muscular fibres of the excretory ducts, and other parts of the organs of secretion; and the coats of the stomach and of the intestines. As the influence of the nervous system on those muscles is of a very pecular kind, and as their motions are governed by different laws from those which regulate the voluntary muscles, it will be necessarv to bestow on them a separate consideration.

(744.) M. Le Gallois, in a work entitled, *Expériences sur le Principe de la Vie, notamment sur celui des Mouvemens du Cœur, et sur le Siège de ce Principe*, thought he had proved that the muscular power of the heart is derived altogether from the spinal cord, and not from the brain. He found that on injuring the spinal cord, the heart is so enfeebled as no longer to be capable of propelling the blood; but that the contractility of the heart may continue unimpaired when the brain, and even the whole head, is removed, provided respiration be kept up by artificial inflation of the lungs. He conceived, therefore, that the use of the cardiac nerves is to establish the connexion between the spinal cord and the heart; and that whenever the heart is affected by passions and emotions of the mind, which produce their first changes on the brain, it is influenced through the medium of the spinal cord, which is itself affected by the brain. Dr. Wilson Philip has shewn the fallacy of this conclusion; and has completely established, by direct experiment, that under similar circumstances, the brain has just as much influence on the motions of the heart as the spinal cord. The motion of the heart is no more affected by the removal of the spinal cord than by that of the brain, if the same precautions be taken in either case, of effecting the removal slowly, and with as little disturbance to the remaining parts of the system as possible. If, on the other hand, either the brain or the spinal cord be suddenly crushed by a blow, which at once destroys its texture, the heart is instantly paralysed, and its motions cease. Although the muscular fibres of these organs are not excited to contraction by irritations of any kind applied to their nerves, nor their contractions arrested by the section of those nerves, yet these actions are immediately accelerated by the application of chemical stimulants, such as alcohol, either to the brain or to the spinal cord; and retarded by the application of opium, tobacco, or other narcotic agents, to the same parts.

(745.) It would appear, therefore, that although there is no essential difference between the real nature of the irritability of the involuntary, and that of the voluntary muscles, yet that each is influenced by different kinds of stimuli, and by stimuli applied through a different medium. Mechanical stimuli, such as punctures or partial divisions of the fibres of the muscles of voluntary motion, act on them only through the medium of their nerves; and if applied to the parts of the brain whence these nerves originate, will throw those muscles into the most violent spasmodic contractions. The heart, on the contrary, is but slightly disturbed in its movements by the same kind of injury done to the brain or spinal cord, provided the injury be confined to a small portion of those organs. That important organ appears to be affected only in proportion to the extent of the parts that have suffered injury, and to the suddenness with which that injury has been inflicted; as is exemplified by wounding the brain rapidly in many directions. Chemical stimuli, on the contrary, applied to any part of the brain or spinal cord, produce considerable and immediate increase of the action of the heart; while the voluntary muscles continue all the while unaffected; and the animal betrays no sense of pain. Accordingly the heart, having no direct dependence on any part of the nervous system, may continue its action when the brain and spinal cord are destroyed, and even when it is itself removed from the body. The nerves with which it is supplied, however, render it capable of being influenced through those causes, as, for example, by the passions, and by various poisons, which affect a considerable portion of the nervous system.

Ganglion system.

(746.) The contractile powers of the other parts of the vascular system, and most of the secreting organs, as well as the irritability of the stomach and intestines, are, like those of the heart, independent of the nervous system, yet capable of receiving an influence through the medium of the nerves; and the same law appears to extend generally to all the involuntary muscles. The extensive nervous communications which are naturally established between the whole system of involuntary muscles, and the organs in which they enter, seem to be necessary in order that any one set of these organs should be subjected to the influence of all the others. This purpose is effected by that complex arrangement of nerves, which has been termed the *ganglionic system*, from the great number of ganglia annexed to them. The great sympathetic nerve forms the principal connecting nerve in this system between all the muscles of involuntary motion; which, through the medium of filaments from the extensive chain of ganglia belonging to this nerve, are placed in connexion with every part of the brain and spinal cord. Each ganglion belonging to the sympathetic system has been considered as a secondary centre of nervous influenee, receiving supplies from all the latter parts, and conveying to the former organs the united influence of the nervous system in general. The muscles of voluntary motion, on the other hand, are subjected to the influence of only small portions of these central parts of the nervous system, and receive their nerves directly from these parts; and usually without the intervention of ganglia, and with comparatively few intermixtures of nervous filaments; such intermixtures being designed for the purpose of effecting combinations with the nerves of sensation, and especially with those which convey impressions relative to muscular motion.

(747.) The ganglia of the sympathetic system have, accordingly, been considered by many physiologists as performing functions similar to those of the portions of the spinal cord exercising mere nervous power; that is, in the language of Dr. Marshall Hall, performing reflex functions, and belonging, together with the branches of the sympathetic nerve, to the excito-motory system.[2]

SECT. VIII.—*Psychological relations of the Sensorium.*

Psycholo gical rela tions.

(748.) In treating of the functions of the nervous system which involve operations both of the body and of the mind, it is very difficult to draw the strict line of distinction between them, and avoid treating of subjects which properly belong to metaphysics. We have endeavoured, in the preceding account of the physiology of man, to confine ourselves strictly to the consideration of the corporeal changes which accompany the different mental affections, and to avoid, as much as possible, encroaching upon the province of the metaphysician. That certain physical changes take place in some portion or other of the cerebral mass in connexion with various mental changes, we have the clearest evidence: but of the nature of these physical changes we are wholly ignorant; nor does the present state of our information afford a shadow of hope that we shall ever gain any more precise knowledge of them. The mental changes, on the other hand, constitute a distinct and separate branch of science; to the knowledge of which we arrive by channels totally different from those which instruct us relatively to the former; namely, by consciousness, and by reflexion on the series of phenomena furnished to us by consciousness. These two subjects of study, the material and the immaterial, however numerous may be the subtle and inscrutable links that connect them, constitute two worlds, which in our conception must for ever remain totally distinct; nor is it even possible for us to conceive how any knowledge which we can obtain with relation to any physical changes in our corporeal frame, or any physiological laws that may regulate the succession of those changes, can in the smallest degree assist us in understanding the phenomena of intellect, and the affections of the soul.

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[1] *Quarterly Journal of Science*, xiv. 93.

[2] See Grainger's *Observations on the Structure and Functions of the Spinal Chord.*

unctions the brain.

(749.) The brain has been very justly regarded as the organ of the mind; that is, the corporeal instrument invariably employed in the operations of the mind. This is a necessary corollary from the proposition that no mental operation can take place without the co-existence of some physical change in the brain. But a second proposition, the converse of the former, has been advanced; namely, that the mental operations are the "functions of the brain." But this latter proposition would be true only on the supposition that the physical change in the brain, and the corresponding mental change of which we are conscious, are one and the same thing. Until this fundamental doctrine of materialism, namely, the identity of matter and mind, be proved, we cannot include under the functions of the brain, both the mental changes and the corporeal changes. The physiological office, or function of the brain is the production of certain corporeal changes, connected in some inexplicable manner with certain mental changes; which two classes of changes are in their nature, as far as we are capable of forming any conceptions of them, radically and essentially different from each other.

(750.) The ambiguity of ordinary language is, indeed, a frequent source of confusion of ideas on this subject. We speak correctly when we say that the eye is the organ of vision, because it is an instrument without which vision could not be exercised; but were we to regard vision as the function of the eye alone, we should evidently be guilty of inaccuracy in extending too far the purpose of that instrument. The function of the eye is to produce certain impressions upon the retina, which impressions are but links in the series of changes, of which only the last constitutes vision. These impressions made on the retina are followed by changes in the course of the optic nerves, and these again by changes in the sensorium. The function of the optic nerves, and of that part of the sensorium in which they terminate, is the production of these physical changes. Vision, an affection of the mind, is undoubtedly the effect of these physical changes, but is not properly the function of any of these organs, except the term function be used in that loose and popular sense, in which it is made to embrace all the remote consequences of the phenomena, in the production of which the organ in question is concerned. In this sense, indeed, vision, and all the mental affections consequent upon vision, might certainly be said to be functions of the eye; but in the strict philosophical sense, the function of the eye is limited to the formation of images on the retina, and the impressions thereby received by the retina; and, in like manner, the proper function of the brain is the production of certain physical changes in the fabric of the brain, consequent upon certain impressions made on the nerves by external causes, and consequent also upon certain internal affections of the mind, which are capable of exerting on it this influence.

(751.) The affections of the mind are very various and complicated; a great multitude of ideas and associations are treasured up in it, and constitute a variety of powers, of faculties, of propensities, of instincts, and of passions. The conformation of the brain, which is the organ of the mind, is also very complex, and appears to consist of an assemblage of different parts, constructed evidently with extreme refinement, and arranged with great care, and with very elaborate design. The idea naturally suggests itself, that these different portions recognised by the anatomist may, perhaps, have some correspondence with the several faculties into which the phenomena of the mind have been analyzed by the metaphysician. This question has indeed been often started, and is quite distinct from that of the materiality or immateriality of the soul; for it is perfectly conceivable that if the immaterial soul acts by means of material organs, and receives impressions from those organs, its different operations may require different organs. But this subject, together with the theories to which it has given rise, having been already amply discussed under the Treatise on PHRENOLOGY, we need pursue the subject no farther in this place.

SECT. IX.—*Sleep.*

Sleep.

(752.) Whilst the functions which have for their object the reparation of the state of the body, and which include assimilation, absorption, circulation, respiration, secretion and nutrition, continue in constant activity, all those connected with sensation and volition require intervals of repose, and cannot be maintained beyond a certain time without great exhaustion of the nervous power. These periodical intermissions in the activity of the animal functions, so necessary for the renovation of the power on which they are dependent, constitute *sleep*. The eye-lids close to protect the eye from injury, and the eye-ball is turned upwards; the external senses and all the active intellectual operations are suspended; the voluntary muscles are relaxed; and we become insensible to all external impressions. The movement of the involuntary muscles continue, though with somewhat less energy than during our waking hours. The heart beats with diminished force and frequency, and the muscles of respiration act more slowly; but the inspirations are more full and deep, and the secretions are in general less abundant; but digestion and absorption are carried on with great activity. The power of sensation, though blunted, is not altogether lost during sleep, as is proved by the continuance of that part of the movements of the muscles of respiration, which depend on sensation. Instinctive movements of the limbs, producing a change of posture, frequently take place from an obscure sensation of constraint at their continuing long in the same position. Any unusual impressions made on the organs of the senses are felt during sleep, and even remembered; and, if the impression be sufficiently vivid, will interrupt sleep.

Dreaming.

753. Neither is the mind wholly inactive during sleep; it is still occupied with a succession of ideas, which is often more rapid than when we are awake; the imagination is even more vividly exerted, and the images that pass before the mind are considered as realities. This constitutes *dreaming*, a state which is characterized also by the peculiar circumstance of the want of all voluntary power of directing the succession of ideas. Trains of ideas and images commence and follow one another, being indissolubly linked together by those laws of association which are independent of volition.

Somnambulism.

(754.) An extraordinary modification of dreaming occurs in what is called *somnambulism*, or sleep-walking; where the will recovers a certain degree of power over the mental operations, and over the voluntary muscles both of speech and of motion, while the body is still less capable of receiving external impressions than in ordinary sleep. In this peculiar kind of sleep, the insensibility to most external impressions is so profound, that it is scarcely possible to awaken the person without employing a considerable degree of violence. When at length he does awake, which often happens as suddenly as from natural sleep, he usually retains little or no recollection of what happened to him, or of what he did while in this singular state.

(755.) A state very similar to that of natural somnambulism, is induced in some nervous constitutions, especially those of young females, by certain manipulations which produce a long-continued reiteration of impressions made on the senses, and which probably act through the medium of the mind. These have been ascribed to a special agency, termed *animal magnetism*, or *mesmerism*. For an account of these effects, we must refer our readers to the article MAGNETISM, ANIMAL.

CHAP. XVII.—THE VOICE.

The voice.

(756.) The function of the voice, and of its modulation into articulated sounds, by which it is rendered subservient to speech, has been already pointed out as an important part of the animal economy of a being designed, as man evidently is, to hold extensive communion with his fellow creatures, and effect the rapid interchange of ideas and feelings, through the medium of the sense of hearing, (§ 24.)

Acoustic principles.

(757.) In order to understand the mode in which articulate sounds are produced, it will be necessary again to advert to the principles of acoustics, of which a brief account was given in introducing the subject of the physiology of hearing, (§ 623.) The object to be accomplished in the function of the voice is the production, not so much of single sounds, (such as those which result from single impulses given to the air,) but of continued sounds, composed of reiterated vibrations, repeated at short and equal intervals, and constituting a *musical note*. There are two principal modes in which such sounds are produced; the one, that which is practised in stringed musical instruments, in which the impulses are given to the air by the vibrations of solid bodies, which are generally chords having different degrees of tension; and the other, such as is adopted in wind instruments, where the air is thrown into undulations at regular intervals, by alternations of expansion and condensation, generally taking placing during the passage of a stream of air through a cavity in which it suffers certain reflexions and reverberations, alternately impeding and promoting its progress. In many cases the effect is obtained by a combination of both these means, as in a hautboy, where an elastic plate, or *reed*, is placed in the course of the air which is passing along a tube, capable by its form of producing a musical note, independently of such addition.

Organs of the voice

(758.) In the construction of the vocal organs of man, nature has resorted to combinations of this kind. Advantage is taken of the function of respiration to convert the passages through which the air is admitted to, and expelled from the lungs, into a sounding instrument; by adapting to the upper part of the trachea, a curious mechanism, consisting of a frame-work of elastic cartilages, with an apparatus of ligaments, muscles, membranes, and mucous glands, the assemblage of which is termed the *larynx*. The aperture through which the air passes is denominated the *glottis*. Here it is that the breath is *vocalised*; that is, rendered not only sonorous, but also modulated in its pitch, so as to give rise to a musical sound. Modifications are subsequently impressed on these sounds, by the changes which the undulations are made to undergo in the cavities of the pharynx, of the nostrils, and of the mouth, according to the various forms and dimensions given to those cavities by the motions of the muscles of the pharynx, the velum pendulum, the uvula, the tongue, the cheeks, and the lips; and according to the obstacles placed in the way of the passage of the air by the movements of these parts, and the application, in particular, of the tongue and of the lips to the palate and to the teeth.

(759.) The cartilages of the larynx are five in number, namely, the *thyroid*, the *cricoid*, the two *artenoid*, and the *epiglottis*. The *thyroid*, which is also called the *scutiform*, or shield-like cartilage, is placed at the upper and fore-part of the larynx, and is the largest of the whole. It consists of two lateral wings of a quadrangular form, uniting in front in a longitudinal angle, which is felt projecting in the fore-part of the throat, and has obtained the name of the *pomum adami*. From the posterior corners, four processes project, called its *cornua*, distinguished into two *superior*, and two *inferior*. The *cricoid*, *annular*, or *ring-like* cartilage, is placed below and behind the former; and it has four articular surfaces, two below, for its connexion with the inferior cornua of the thyroid cartilage, and two above, for the articulation of the *arytenoid* cartilages, which are bodies of a pyramidal shape, much smaller than the rest, and placed one on each side, upon the upper posterior and lateral parts of the cricoid cartilages. They give attachment to ligaments, and compose a part of the sides of the opening called the *glottis*. The whole passage is lined internally by a delicate mucous membrane.

(760.) The *epiglottis* is a cartilaginous lid, which has a pointed shape, resembling the leaf of an artichoke. It is fixed at its base to the os hyoides, to the thyroid cartilage, and to the root of the tongue; and hangs obliquely backwards over the opening of the glottis, which extends in a line from behind forwards, and is formed by the approximation of the vocal ligaments, or *chordæ vocales*. These ligaments, which consist of fibres endowed with a high degree of elasticity, are covered with the fine membrane which invests the whole of this delicate apparatus, and extends down the trachea into the lungs, and above to the posterior fauces. These are attached together in front to the thyroid cartilage, and behind to the arytenoid cartilages, where, in the relaxed condition of the organ, they are at some distance from each other, so as to leave a triangular opening for the passage of the air. The effort to speak, or to utter a vocal sound, commences with the action of certain muscles, more particularly the *crico-thyroidæi*, which stretch the vocal ligaments, and the *crico-arytænoidei laterales*, and the *arytænoidei transversi and obliqui*, which conspire to make the arytenoid cartilages approximate. By these combined actions, the vocal ligaments are brought near to each other, in parallel directions, so that the interval between them or *rima glottidis*, as it is called, is reduced to a mere narrow linear fissure.

Formation of vocal sounds.

(761.) When, therefore, the air is forcibly propelled from the lungs through the glottis, while the vocal chords are in this approximated position, different vocal sounds will be produced, according to the degree of tension which is given to the chordæ vocales. The greater the tension of these ligaments, the more frequent will be their vibrations, and the higher the pitch of the note they produce. The loudness of the sound emitted is proportioned, not to the frequency of the vibrations, but to their extent, or the magnitude of the excursions made by the vocal chords in vibrating. The varied degrees of tension which can be imparted at will, and instantaneously, to the vibrating ligament of the larynx, by the finely regulated actions of their different muscles, constitute the chief source of superiority in the vocal organ to any instrument of human invention.

(762.) The muscles above enumerated as giving tension to the vocal ligaments, and clossing the glottis by the approximation of the arytenoid cartilages, are opposed by their antagonists the *thyreo-arytænoidei*, which relax the vocal ligaments, and place them in the vocalizing position, and by the *crico-arytænoidei postici*, which separate the arytænoid cartilages, and thereby open the glottis. Thus the instrument we are considering is capable of an infinite number of changes of form, and susceptible of the finest modulation.

(763.) It should be stated, however, that many physiologists have maintained that the musical tones of the voice depend, not merely on the tension of the vocal ligaments, but also on the size and form of the aperture through which the stream of air is propelled, and that the larynx partakes as much of the properties of a wind as of a stringed instrument. The principal advocate of this opinion was Dodart, whose first paper[1] contains a historical account of the views on this subject taken by the earlier physiologists. His chief antagonist in this controversy was Ferrein,[2] who compares the larynx to a violin, or harpsichord, and conceives that the voice is produced by the vibrations of the edges of the ligaments of the glottis; and compares the action of the air to that of a bow setting these parts into vibration. The hypothesis of Dodart has been adopted by Blumenbach, who conceives the action of the larynx to be analogous to that of the flute. But the generality of physiologists consider the action of the ligaments of the glottis to be vibration, and similar to that of strings resounding by their tension alone. Such is the view taken of the subject by Dr. Young,[3] Soemmerring,[4] Magendie,[5] Willis,[6] and Mayo,[7] who all maintain that the voice depends on the vibrations of the chords; the frequency of which must, according to all acoustic principles, be regulated solely by the tension of the chords.

(764.) Dr. Willis observes that, for the production of laryngeal sounds, something more is requisite than a definite tension of the vocal ligaments. He has shown, by experiment, that in order that the edges of two membranes, such as those made of leather or of Indian rubber, opposed to each other with a narrow interval, may vibrate, the parts of the membrane near their edges must be brought parallel to each other. Comparing this disposition of membrane in his experiment with the parts of the larynx, he supposes that the latter will not vocalize, unless some change, independent of, and superadded to, the tension of the ligaments, be produced in their relative position.

(765.) The experimental proof on which Mr. Willis founds his conclusion that some change in the relative position of the vocal chords is necessary to produce an audible vocal sound, is the following. If the finger be placed upon the membrane which intervenes between the thyroid and cricoid cartilages, their approximation or increased remoteness may readily be felt. Now their approximation being produced by the action of the crico-thyroid muscles, involves an increased tension of the ligaments. But it is possible by an effort to keep these cartilages approximated, while something is still wanting in the internal arrangement of the larynx, to fit it for the production of sound. When the thyroid and cricoid cartilages are thus approximated, and the ligaments thus shewn to be in a state of tension, if air be impelled through the larynx, sound does not necessarily follow; the ligaments have still, Mr. Willis concludes, to be placed in the vocalizing position.[8]

uence of trachea.

(766.) There are still other parts of the vocal apparatus connected with the sounds produced at the larynx, which require to be adverted to. Among these the varying conditions of the trachea appear to have the greatest influence on those sounds, and of this influence Mr. Wheatstone proposes the following theory:[9]

"Such a vibrating apparatus as we have described the ligaments of the glottis to compose, is by itself capable, from the varying tension of those ligaments, of producing all those sounds of which we find the voice to be susceptible. But the intervention of a tube between the lungs and the larynx, must necessarily exercise an important influence on the voice, though it has never yet been taken into consideration. For, if we unite such an apparatus, or a free reed, which may serve as a substitute for it, with a tube (supposing it for the moment fixed to a determinate degree of pitch), it is found, that, unless the column of air in the tube is of such a length as to be separately capable of producing the same number of vibrations, the sound cannot be obtained in its greatest force and purity, and that when the tube is half this length, the discordance between the tube and the reed is so great, as to prevent the production of the sound: between these limits the sound is intermediate in intensity and quality. This influence of the tube is by experiment found to be the same, whether the tube be placed after the reed, as in several wind instruments, or before it, as in the vocal organ. We will now suppose the tube to be unalterable in its length, and the reed necessarily to undergo all its varying modifications of pitch; the sounds, instead of being of even quality, will be irregular in intensity, and require different degrees of effort to produce them, while, in some parts of the scale, they will be totally extinguished. All this may be prevented, and the utmost regularity obtained, by shortening the tube, in proportion as the vibrations of the reed increase in frequency. The trachea is obviously incapable of changing its length within limits sufficiently considerable to serve this purpose; but Savart's experiments have shown, that a tube of constant length may be made to produce a great range of sounds, by making it of elastic sides susceptible of variable tension. The analogy between such a tube and the trachea is perfect."

(767.) One mode of giving increased tension to the windpipe is the action of the transverse muscular fibres which bind the ends of its cartilages together. Another is the elevation of the larynx, which follows in so remarkable a degree the elevation of the pitch of the voice. Practice in singing improves the voice, partly by giving us a more ready command over the tension of the trachea, and partly by enabling us to regulate and vary the opening of the glottis while we preserve the tension of the vocal chords.

Formation of articulate sounds.

(768.) Such being the mode in which vocal sounds are produced in the larynx, the next step in the inquiry will relate to modifications they receive from the shape of the cavities of the pharynx and mouth, through which the expired air has yet to pass. When thus modified they become not merely vocal, but *articulate* sounds, and constitute the elements of speech.

(769.) This branch of the subject has been ably investigated by Sir Charles Bell,[10] who has traced the influence which the changes produced by the muscular actions of the tongue and fauces, on the shape of the cavities of the mouth and pharynx, have on the resulting articulate sounds. He has examined the succession of actions which must be performed before a word can be uttered, and which he finds to consist in the compression of the thorax, as well as the adjustment of the glottis, the elevation and depression of the larynx, and the contraction of the pharynx.

Pronunciation of vowels

(770.) The elementary articulate sounds of a language consist of vowels and consonants. Vowels are continued sounds, produced when the passage of the air through the fauces is uninterrupted, the fauces being only more or less narrowed. Each vowel requires a different elevation of the tongue or contraction of the lips. Thus the sound of the broadest pronunciation of the letter *a*, which occurs in the word *awe*, results from the lowest position of the tongue, giving its greatest depth to the cavity of the mouth. The ordinary sound of *a*, as in the word *age*, is produced by a certain elevation of the tongue, reducing considerably the capacity of the mouth. The vowel *e*, pronounced as in *eve*, is sounded by raising the tongue still more, so as to leave a more contracted channel for the exit of the air. The positions for *o* and *oo*, are obtained by placing the fauces in the position first described, namely, that for *au*, and then approximating the lips.

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[1] *Mémoires de l'Académie*, pour 1700, p. 244; 1707, p. 66.

[2] Ibid. pour 1741, pp. 409, 416, 422.

[3] *Lectures*, p. 400, and *Philosophical Transactions* for 1800, 141.

[4] *De Corporis Humani Fabrica*, vi. 93.

[5] *Physiologie*, i. 106.

[6] *Cambridge Philosophical Transactions*, iii. 231.

[7] *Human Physiology*, 3d edit. p. 350.

[8] See Mayo's *Outlines of Human Physiology*, 3d edition, p. 350, 351, from which the above account of Willis's theory is extracted.

[9] Ibid. p. 252.

[10] *Philosophical Transactions* for 1832, p. 299.

Of consonants.

(771.) The pronunciation of consonants is effected by interruptions to the passage of the air in some part of the cavity of the mouth, by various motions of the tongue and lips, which, when applied to the palate or the teeth, narrow or close the channel for its exit.

(772.) The following experiment is mentioned by Mr. Mayo[1] as having been made by M. Deleau, demonstrating that the articulation of vocal sounds takes place in the fauces. He introduced through the nostrils into the pharynx a flexible tube, and, by means of a gum bottle, impelled air through it into the fauces; then, closing the larynx, he threw the fauces into the different positions requisite for producing articulate sounds, when the air impelled from the gum bottle became an audible whisper. Dr. Bennati repeated this experiment, allowing at the same time laryngeal sounds to pass into the fauces, when each articulated letter was heard double, in a voice at once, and in a whisper.

(773.) Consonantal sounds may be divided, first, into *aspirates* and *sonants*, or, secondly, into *continuous* and *explosive*.

(774.) The aspirates are those which may be rendered audible without a vocal sound, as is the case with *p*, *t*, *k*, *h*, *f*, *th*, *s*, and *sh*. The sonants are those which, without any appreciable difference in the shape of the fauces from the form required for the pronunciation of the preceding to which they are allied, are not heard without a vowel sound, either previously uttered, as in *b*, *d*, *g*, *v*, *z*, and *l*, or subsequently, as in *g*, or in conjunction with it, as in *r*.

(775.) Continuous consonants are pronounced when the vocalized air passes through some part of the organ, previously rendered very narrow. Explosive consonants are those which are produced by the interruption to the current of air occasioned by the entire closing of the passage, and its being allowed to burst out with some force by the sudden opening of the same passage.

(776.) The nasal consonants, *m*, *n*, and *g*, are distinguished from the rest by the peculiar character of their articulation arising from the breath being allowed to pass through the nostrils; while in the pronunciation of the others, the soft palate being raised closes the posterior nostrils, and prevents the sound from diffusing itself in that direction.

(777.) We refrain from entering into any further details with regard to the position of the fauces, tongue, and lips, in the pronunciation of the different consonants, having already treated of this subject at some length, in the article Deaf and Dumb, to which we shall therefore refer our readers.[2]

Pitch of the voice.

(778.) The low pitch of the voices of men compared with those of women and boys, arises both from the greater general size of the larynx, and also the greater length of the chordæ vocales, which has been found to measure nearly double that of the latter. In attempting to utter high notes, voices, naturally grave, assume the character of the *falsetto*. This, Mr. Willis supposes, may result from the shortening of the vocal chords; but Mr. Wheatstone is disposed to ascribe it to the tension given to the windpipe being such as to reinforce the laryngeal sounds by subdivisions.

(779.) Some curious observations on the mechanism of the voice during singing have lately been given by Dr. Bennati,[3] who states, that the compass of his own voice extends to three octaves. He concludes from his inquiries, that it is not merely the muscles of the larynx which modulate the sounds, but those also of the os hyoides, and the other neighbouring parts. He mentions that, on removing part of the tonsils, the operation was followed by the raising of the voice half an octave, without altering its compass. Mr. Mayo supposes this effect to result from the cicatrix stretching the mucous membrane of the larynx, and thus giving increased tension to its inner surface.

CHAP. XVIII.—GENERATION.

Sect. I.—*General Views.*

Generatio

(780.) As far as we are permitted to scan the designs of the Almighty Creator in the formation of organized beings, they appear destined to a mode of existence characterized by perpetual mutation. Their living state is made to consist of a perpetual series of actions and reactions, in which nothing is intended to be permanent, not even the materials of which the combinations constitute the substance and organs of the body. All is subject to displacement, alteration, renewal, and renovation, during a certain definite period, which varies in each species, according to the primordial law of its constitution; and all must bend, when that period is exceeded, to the imperative law of mortality, to which every individual endowed with life is subjected.

(781.) But the same counsels which prescribed these limits, and decreed the extinction of life, and the dissolution of the frame in which it had resided, have providently ordained most ample means for the continuance of the race, and the indefinite multiplication of its numbers. Individuals perish, but the species is preserved in endless perpetuity by means of Generation; a function of paramount importance in the economy of nature, and for which the most ample provision has been made, and the greatest solicitude manifested to secure the accomplishment of its purposes. Nutrition and generation, indeed, constitute the only functions which can be said to be universally exercised by all organized beings, whether belonging to the vegetable or the animal kingdom, or whatever rank, from the lowest to the highest, they may occupy in the scale of nature.

(782.) But although the purpose is thus manifest, and the provisions for its execution thus effective and even exuberant, the immediate agency by which one living being is rendered capable of giving rise to another similar to itself, is enveloped in the most profound and most hopeless obscurity. No means within the compass of our understanding, no combination of the powers of matter which we can possibly conceive, no process of which the utmost stretch of human imagination can give us the most remote idea, has ever made the least approach towards the solution of this most inexplicable of all enigmas,—the production, nay, the apparent creation, of a living plant or animal by powers inherent in the organization of a similar being. We must content ourselves, in studying this inscrutable mystery, to observe and generalize the phenomena, in silent astonishment at the marvellous manifestation of design and of power exhibited in this department of the wonderful works of the Almighty.

Plans of productio

(783.) Various plans of reproduction are exhibited in the different classes of animals, but they are all reducible to three general heads, which may be designated by the titles of *fissiparous*, *gemmiparous*, and *sexual* reproduction. Many physiologists, however, have been disposed to admit the existence of a fourth mode of reproduction, which they have termed *spontaneous*, or *equivocal generation*. It is contended by the advocates of this hypothesis, that in many of the lower tribes, instances occur of the formation of animals without the intervention of any parents, and produced by the spontaneous union of certain elements, which might fortuitously be found in juxtaposition, in collections of the decomposing materials of other organized structures, after the extinction of their life. Although this opinion was at one period the generally prevailing doctrine, it is now, in consequence of the more extensive knowledge which has been obtained of the procedure of nature in the multiplication of animals, very generally exploded. The principal arguments in its favour were, in the first place, those drawn from the existence of intestinal worms, and other parasitic entozoa, in the bodies of animals, the germs of which appear neither to be introduced into the system from without, nor to have any assignable origin from within; secondly, those derived from the rapid appearance of infusory animalcules in all infusions of decaying animal or vegetable matter that are exposed for a short time to the air. But the analogy of every other department of the animal and vegetable kingdoms is directly opposed to the supposition that any living being can arise, unless it has originally sprung from an individual of the same species as itself, and of which it once formed a part. The difficulty which the hypothesis of the spontaneous production of infusory animalcules professes to remove, consists in our inability to trace the pre-existence of the germs in the fluid where these animalcules are found to arise, and to follow the operations of nature in these regions of infinite minuteness. But the recent discoveries of Ehrenberg relative to the complete organization of these beings, in which he in many instances detected the presence of generative organs, has very much diminished the difficulty of conceiving the possibility of their ova, so minute as to be wholly imperceptible, existing in great numbers in the fluid, or even in the atmosphere, and giving rise to all the observed phenomena.[1]

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[1] *Outlines of Human Physiology*, p. 354.

[2] See also Haller's *Elementa de Physiologiæ*, ix. 4; Dr. Young's *Lectures*, ii. 276; and the work of Mr. Mayo, already quoted.

[3] *Annales des Sciences Naturelles*, xxiii. 32.

issipa- us generation.

(784.) *Fissiparous generation*, the simplest of all possible modes in which the species can be multiplied, consists in the spontaneous and gradual division of the body of an individual animal into two or more parts, which, when the division is completed, separate, and each soon assumes the form, and grows to the size of the parent, and becomes capable of performing all the functions which originally belonged to the undivided animal. The most common form of this mode of generation is met with in some of the simpler of the infusoria, as the monas, the gonium, the cyclidium, the vorticellæ, and the volvox. In the instance of the volvox, however, we find an approach to the next order; for the young are seen forming within the body of the parent, which is, in course of time, reduced to a mere membranous vesicle, and then bursts, and is torn into shreds, setting free the enclosed young, each of which immediately begins to execute its independent movements in the fluid.

emmipa- us generation.

(785.) *Gemmiparous generation* occurs when a new individual grows from the parent as a bud or sprout; at first exhibiting but little resemblance in shape or structure to the parent animal, but gradually assuming that form while still adhering to it, and being afterwards detached to commence an independent existence. Numerous examples occur of this mode of reproduction among the lower orders of zoophytes, such as animals belonging to the tribe of polypi, of which the hydra viridis, rendered celebrated by the researches of Trembley, may be taken as the type. Sometimes, as happens in the sponge, the actinia, and some of the lower orders of mollusca, the young are formed from small detached masses after they are separated from the body of the parent. These bodies, which are called *spores*, *sporules*, or *gemmules*, are generally of a rounded form and homogeneous structure; and the whole substance of which they are composed is converted during their developement into the new animal. Hence they may be regarded as buds formed in the parent body, but detached from it before the evolution of the new animal begins. In some species these gemmules are formed in all parts of the body indiscriminately; but in most others there is a particular generative organ provided for their formation.

Sexual generation.

(786.) In by far the greater number of organized beings no reproduction takes place except by the co-operation of two kinds of generative organs; laying the foundation of the distinctions of sex, and constituting *sexual generation*. As characterising the female, there is, in the first place, an organ, termed the *ovary*, of which the office is to form the *ova*, or eggs. These are organized bodies of a determinate shape, within which we first find the earliest rudiments, or *germ*, of the future animal contained in a fluid, which is itself enclosed in a vesicle. But the ovum, or, more properly speaking, the *ovulum*, thus formed exclusively by the female organs, never advances in its developement beyond this stage, and can never give rise to a new animal, unless it receive a certain vivifying impression given to it by the contact of a peculiar fluid, denominated the *semen*, which has been prepared by a totally distinct apparatus, constituting the male organs.

Fecundation.

(787.) The nature of the impression thus made by the seminal fluid on the ovulum, or immature ovum, and which constitutes its *fecundation*, and awakening in it a power of reproduction, which had before remained dormant, is wholly unknown; nor is it accompanied with any immediate alteration in its appearance or structure. None of the parts of the new animal can yet be discerned in the fluid contents of the ovulum, the great mass of which consists of a fluid holding in suspension granules of albuminous or oily matter; and a certain time must elapse, even in the most favourable circumstances, before the formative process exhibits its effects. The form of the egg is given by the external coverings, and there is in every egg a determinate part, at which the minute rudimental germ of the embryo is first visible. It is to this germ that the power of independent life and developement appears more immediately to belong, the granular fluid serving only as nutriment laid up in store for the supply of materials for growth.

Essential processes.

(788.) Thus the processes essential to sexual reproduction consist, first, in the formation of an ovulum by the female organs; second, in the secretion of the seminal fluid by the male apparatus; third, in the application of the seminal fluid to the ovulum so as to confer on it fecundity.

Varieties.

(789.) The mode in which this application is made differs according as the male and female organs are both contained in the system of the same individual, (as occurs in *monœcious* plants and hermaphrodite animals,) or exist separately in different individuals, (as in *diœcious* plants, and all the higher classes of animals.) In the former case, self-impregnation may take place, either by the required seminal access being effected internally in each individual independently of any other; or, in other cases, by the concurrence of two individuals in sexual union which reciprocally impregnate one another, (as is exemplified in the leech, the earth-worm, and the snail.) In the second division, where the male, or fertilizing organs, are possessed exclusively by one individual, and the female organs, or those producing the germ, by another, impregnation of the ova may take place either after their exclusion from the body of the female parent, by their contact with the male semen ejected on them when thus excluded, (as happens in the case of fishes and batrachian reptiles,) or within the body of the female; for which latter purpose, a new function, that of *copulation*, becomes necessary. This last mode of procedure is had recourse to by nature in by far the largest portion of the animal kingdom, including all the tribes of insects, nearly all the mollusca, and all warm-blooded vertebrated animals.

Modes of developement.

(790.) All the subsequent phenomena relate to the developement of the embryo thus brought into existence; to the supply of nourishment for its growth; and to the advantages of situation, of warmth, and of protection, which are necessary for the favourable procedure of the vital powers in the progress of this developement.

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[1] See Bridgewater Treatise, *on Animal and Vegetable Physiology*, vol. ii. p. 591, note.

Oviparous.

(791.) Various plans are resorted to for conducting these processes of developement of the fecundated ovum. In that which is termed *oviparous generation*, the ovum, during its passage through the oviduct, receives the addition of a considerable quantity of nutritious matter, sufficient for the supply of all the materials requisite for its growth, until the period when it is capable of procuring food for itself; and it also acquires a capsule, or substantial covering, frequently of a calcareous nature, fitted for its protection under the circumstances in which it is to be placed. When thus formed it constitutes an *egg*, or complete ovum; and in this form it is either excluded from the body of the female parent, and hatched, if already fecundated, by the influence of external warmth; or if not previously fecundated, this change is accomplished by the seminal fluid of the male being shed upon it. The former case, which implies sexual congress, is exemplified in all insects and birds: the latter, which requires no such congress, obtains in fishes, and many of the reptilia. Both are comprehended under the term *oviparous animals.*

(792.) In a few instances the eggs, previously fecundated within the body of the female, instead of being expelled, remain in the oviducts until they are spontaneously hatched, and the young are then brought forth alive. This phenomenon, which is exhibited by many cartilaginous, and a few osseous fishes, by several reptiles, and by some gasteropodous mollusca, insects, annelida, and entozoa, has been called *ovo-viviparous generation.*

Mammiferous.

(793.) In *mammiferous generation*, on the other hand, the ovum, which is not perfected in the same degree as in the two former cases, remains within the female, and is attached, by the medium of a substance called *the placenta*, to the inner surface of an organ termed the *uterus*, where it receives nourishment from the maternal system, and where it remains until it is capable of independent life, and it is then brought forth. This retention during growth in the uterus is termed *utero-gestation*, and its subsequent exclusion is termed *parturition.* The young of mammalia after birth, although they cease to be organically connected with the mother, continue to derive from her a certain quantity of sustenance in the form of milk, which is a secretion from certain glands termed *mammæ*, the possession of which is the characteristic feature of this class of animals. An exception occurs in the case of marsupiate animals, in whom the young leaves the uterus at a very early period of its formation, while it is yet of a very small size, and its organs are comparatively imperfectly formed. On being born it is introduced by the mother into a pouch, termed the *marsupium*, formed by a folding of the integuments of the lower part of the belly; and a short time after it has been deposited there, it is found attached by its mouth to one of the nipples of the mammæ, which are concealed within the marsupium, and there receives its nourishment until it has acquired sufficient size and strength to quit its habitation. *Monotrematous generation*, which is peculiar to the ornithorynchus and echidna, is not yet perfectly understood. The generative organs, and the ova within the ovaries, in these animals, partake in a great degree of the oviparous type; but they are also combined with the presence of mammary glands, which perform the office of lactation, as in the strictly viviparous class of animals.

(794.) The following table, which is nearly that given by Dr. Allen Thomson,[1] exhibits a synoptical view of the various forms of the reproductive process occurring in different classes of animals:—

Modes of Reproduction.	Non-Sexual,	*Fispasirous,* .	A. The parent splits into two or more parts, each part becoming a new animal. 1. By transverse fissure. 2. By longitudinal fissure. 3. Irregularly. B. The parent bursts, and the included young are discharged.
		Gemmiparous, .	A. *Buds* sprouting from the parent stock. B. *Gemmæ.* or Sporules, formed— 1. In all the parts of the body. 2. In one part only.
	Sexual,	*Monœcious,* or Hermaphrodite,	Both sexual organs contained in the same individual. 1. By self-impregnation. 2. By mutual impregnation.
		Diœcious, .	A. *Oviparous;* eggs laid, and afterwards hatched. 1. Eggs fecundated externally. 2. Eggs fecundated internally. B. *Ovo-viviparous;* eggs hatched within the maternal body. *Mammiferous;* the parent suckling the young by mammæ. 1. *Monotrematous.* 2. *Marsupial.* 3. *Placental,* or strictly *viviparous.*

(795.) A wide range of inquiry is here opened to us, comprehending, if we were to include in its field the whole of the animal kingdom, an immense multitude of facts, to the complete study of which the labours of a whole life would be inadequate. We are, however, to confine ourselves, at present, to the view of human physiology; but even here the great extent of the subject obliges us to reduce within a narrow compass the account we have to give of this important and interesting department of the science. For this purpose, after a short description of the circumstances relating to the unimpregnated ovum, we shall proceed to the physiology of the male and female systems respectively, bringing its history to the period of the fecundation of the ovum. This latter subject will lead us to consider some of the most celebrated theories of generation; after which we shall briefly consider the phenomena of utero-gestation and parturition, which are functions belonging exclusively to the female parent, but which accompany and are accommodated to the successive changes attending the developement of the fœtus. Of these latter changes, relating to the system of the new individual, it will be more convenient to give the history separately.

Sect. II.—*Unimpregnated Ovum.*

(796.) Much difficulty is necessarily experienced in obtaining direct evidence of the early changes occurring in the process of human generation, from the scanty opportunities allowed us of direct observation of those changes, and from our being precluded from resorting to the most instructive fountain of knowledge, namely, experimental research. While, therefore, we obtain occasional views of the actual phenomena which occur in man, we must content ourselves with filling up the chasms in the continuous history of his generation, by the observation of those which are presented in the lower animals that most resemble him in the mode in which this function is conducted, and by remoter analogies derived from other classes.

Structure and functions of the ovarium. Graafian vesicles.

(797.) It is well established, from these combined sources of information, that the essential part of the female system concerned in generation is the *oviary*, or *ovarium*, of which there is one, situated on each side, in the cavity of the pelvis. The ovaries are small capsular bodies, of an oblong, or oval, and somewhat flattened shape, which are enveloped in the fold of the peritoneum, forming the broad ligaments of the uterus. They are composed of a white and loose cellular texture, in which we discover several minute vesicles, or cysts, filled with a transparent fluid, and termed, from the name of De Graaf, who first observed them, the *Graafian vesicles.* Their number is generally from fifteen to twenty in each ovarium, and they vary in size, the largest being about one-third of an inch in its longest diameter. The fluid which is contained in these vesicles is slightly viscid and albuminous, inclining to a yellow colour in the most turgid vesicles, containing numerous granules of an irregular shape, and a few globules of oil, but being otherwise pellucid.

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[1] *Cyclopædia of Anatomy and Physiology*, by Dr. Todd, article Generation, p. 438, to which article we are largely indebted in the compilation of this chapter.

(799.) Besides the peritoneal covering already described, the ovarium has a cellular coat proper to itself. Each of the Graafian vesicles has a double investment; the outer coat consisting of a close filamentous texture; and the internal layer being thicker, softer, and more opaque than the outer, from which it is readily separable after maceration, and having a slightly villous inner surface. The membrane immediately containing the granular fluid above described, also exhibits the appearance of being studded with granules, and is on that account styled the *membrana granulosa.* Within the granular fluid is found a body, composed of closely coherent granules, which has been denominated by its discoverer, Baer, the *discus proligerus,* and which he represented as having a flattened or discoid form. and as forming the bed in which is placed the minute vesicle of the *ovulum,* or germ of the unimpregnated *ovum.* The later researches of Dr. Martin Barry, of which he has given an account in a paper communicated to the Royal Society of London, have thrown further light on this branch of Zoology. The following is a summary of the principal conclusions at which he has arrived on this subject.

ulum.

(800.) The ovulum of all vertebrated animals, and of many of the invertebrata also, is contained in a vesicle, called by some authors the *chorion,* but which Dr. Barry thinks it desirable, wherever found, to call an *ovisac.* He considers the Graafian vesicle of the mammalia, and also the capsule, or *calyx* of oviparous vertebrata, as an ovisac which has acquired a covering; which covering is the "*couche externe*" of the "*capsule de la vesicule de Graaf*" of Baer. The *perfect* Graafian vesicle of the mammalia has been shewn by preceding physiologists to be analogous to the perfect capsula, or calyx of the bird; but the analogy is found by Dr. Barry to be much more remarkable between the ovisacs of these two classes of animals, before these additional coverings have been acquired; and this analogy may also be extended to those of amphibia and fishes, so that, in fact, the surfaces of all the vertebrata are in their original structure essentially the same; a conclusion which Dr. Barry is disposed to extend also to the ovisacs of many of the invertebrata.

(801.) The ovisac, being originally an independent structure, can be better studied in this state than at a later period, when it has become the lining membrane of the Graafian vesicle or calyx. Thus, while the perfect Graafian vesicle of the mammal, and the perfect capsule of the bird, are obviously corresponding structures, there yet exists this difference, that there is a space, filled with a large quantity of fluid in the former, not present in the latter; a difference which does not exist in the early stages of formation, when ovisacs in general appear in this respect to be essentially the same. The structure of the ovisac may be examined, in some mammalia, when it does not exceed in length the 600th, or even 1200th part of an inch; so that in the latter case, a cubic inch would contain 1728,000,000.

(802.) The ovisac of the vertebrata, and perhaps of other animals, is at first of an elliptical form. In the mammalia and birds, myriads of ovisacs and ovula are formed, which never reach maturity. Many of these are formed in the substance of the proper membrane of larger ovisacs, and are therefore termed by Dr. Barry *parasitic ovisacs.*

(803.) The ovisac is formed in a cavity proper to itself, with which it does not appear to have any organic connexion. The granules found in the fluid of the ovisac are very characteristic in their appearance, and imply the presence of albumen in a concentrated form. A stratum of these granules, found on the internal surface of the proper membrane of the ovisac, constitutes, as Baer remarks, a distinct membrane. But the mass of granules described by that anatomist as being discoid, is believed by Dr. Barry to be of a spherical form. This latter observer finds that the ovulum of vertebrated animals is, when first formed, situated in the centre of the fluid of the ovisac, and more or less obviously held there by a flake of granules; and has at first no proper envelope of granules. In the mammalia, there forms around the ovulum a granulous covering of a spherical form, which Dr. Barry terms the *tunica granulosa*; but it has no discoid mass of granules proper to it. At a certain period, the ovulum of the mammalia passes from the centre of the ovum to the periphery; and there, while invested by its granulous tunic, it penetrates the membrana granulosa, leaving behind it a flake of granules. Here it lies quite in contact with the proper membrane of the ovisac, is more or less imbedded in the membrana granulosa, and is supported behind by a mass of granules, sometimes presenting the appearance denominated by Baer the *cumulus.* But this cumulus does not belong to the proper granulous covering, or tunica granulosa, of the ovulum; for it may in some animals be separated from this covering, in the form of what Dr Barry calls the *petasiolus granulosus.*

(804.) After the ovulum has reached the periphery, its tunica granulosa may, at least in some animals, by contact with the membrane of the ovisac, become attenuated, or may even disappear at one side; which circumstance, together with the great transparency of this tunic, may have been the cause of Baer's assigning to it a discoid form. This approximation of the ovulum to the exterior surface of the ovisac, is doubtless for the purpose of exposing it to the action of the fecundating seminal fluid, which reaches it while it is in this situation, and still in the ovary. The next step being now the application of this fluid, we are brought to the next stage of our inquiry, namely, into the series of apparatus and of functions provided for the preparation of the semen, its introduction into the female organs, and its transmission to the surface of the ovulum.

SECT. III.—*The Male System.*

Male organs of generation.

(805.) The preparation of the seminal fluid is the office of the two glandular bodies called the testicles, or *testes.* They are suspended in a portion of common integument having the form of a sac, termed the *scrotum,* by a round band, called the spermatic cord, which pursues a very serpentine course; a plexus of veins, the assemblage of which has received the name of *corpus pampyriforme;* consisting of the spermatic artery, a plexus of absorbents, a plexus of nerves; and lastly, the *vas deferens,* or excretory duct; and they are farther supported by a sub-cutaneous layer of muscular fibres, termed the *dartos.* The scrotum is divided into two chambers, one testis being lodged in each, by a membranous partition, or *septum.* Each testicle is loosely contained in a sac, formed by an external serous membrane, the *tunica vaginalis,* derived from the peritoneum, which forms a cavity for its reception similar to that of other serous membranes. This tunic is reflected, like those of other cavities, over the body of the organ; and the reflected portion, which is called, from its white colour, the *tunica albuginea,* forms the proper capsule of the testis. When this latter tunic is divided, the testis is found to consist of a flattened oval substance, to the upper, outer, and back part of which a narrow and flat slip of substance, called the *epididymis,* is found adherent.

(806.) The substance of the testicle is extremely vascular, and the ultimate branches of its spermatic arteries are collected into small bundles of fine convoluted vessels, separated from one another by *septulæ*, or membranous partitions. From these the *vasa seminifera*, or beginnings of the excretory ducts, take their rise, and gradually unite to form a smaller number of canals of larger diameter, but exceedingly tortuous in their course. On arriving at the surface and back part of the testicle, they suddenly become straight, assuming the name of the *vasa recta;* they, however, again subdivide, and their branches have very numerous communications with one another, composing the net-work of tubes called the *corpus highmorianum*, or the *rete testis.* From the rete testis arise the ducts denominated the *vasa efferentia*, which, after being again contorted into numerous convolutions, form the conical bodies called *coni vasculosi;* these again, alternately join to form the epididymis, already mentioned, and which consists of one slender tube, of enormous length, coiled upon itself into a small compass.[1] The epididymis at length emerges, in the form of a tube of larger diameter, which is the *vas deferens*, and which ascends along the spermatic cord towards the abdomen. On tracing these ducts into the pelvis, we find them passing up by a circuitous route through the spermatic passage, and on reaching the pelvis, again descending by the lower side of the bladder, to the under part of its cervix. Each duct is here connected with an oblong membranous bag, called the *vesicula seminalis;* which is a long blind sac, folded many times upon itself; its open extremity entering the vas deferens at an acute angle. These sacs are supposed to be receptacles for the retention and accumulation of semen, until the time when it is required to be expelled. But Hunter remarked that the fluid contained in them is somewhat different from that obtained from the seminal ducts of the testicle itself; and he therefore supposed that these vesicles secrete a peculiar fluid which may perhaps dilute and add to the bulk of the semen. He even contended that the proper office of these cavities is not that of reservoirs of semen; supporting his opinion by arguments derived from comparative anatomy, which furnishes many examples where no direct communication exists between them and the vas deferens, and others where these vesicles are entirely absent. Notwithstanding these analogies, the prevailing opinion is in favour of the vesiculæ seminales in man being reservoirs of the seminal secretion.

(807.) From the vesiculæ seminales and the vas deferens, the semen is occasionally discharged through a duct common to both, and about half an inch in length, which perforates a body called the *prostate gland*, and then opens on each side into a canal, termed the *urethra*, which is continued from the urinary bladder, close to a small eminence in that canal, termed the *verumontanum*, or *caput gallinaginis*. The prostate gland is of the size of a small chesnut; in shape it resembles a heart, with the apex directed forwards. Its texture is firm and tough; it is divided into two lateral lobes, and one anterior lobe, and contains a great number of follicles, into which a white opaque viscid fluid is secreted. This secretion is discharged by ten or twelve excretory ducts opening obliquely into the urethra, in a furrow at the side of the verumontanum.

(808.) The urethra is a canal, lined by a mucous membrane, serving the double purpose of discharging the urine and the semen. As it proceeds forwards from the neck of the bladder, it passes through the prostate gland, on emerging from which it becomes more contracted in its diameter, and passes under the symphysis pubis. At this part, for the length of about an inch, it is supported only by firm cellular and ligamentous membranes; this part of the canal is termed the *membranous portion* of the urethra. It is then dilated into what is called the *bulb*, or *sinus* of the urethra; and it afterwards receives the ducts of several mucous glands, which have been denominated the *glands of Cowper*, and which are generally very minute, but sometimes have the size of peas. One of these is placed on each side of the membranous portion of the urethra, below which they are united by an isthmus; and the duct of each, about three inches in length, opens by perforating the mucous membrane lining the spongy body of the penis. Mucus is also furnished to various parts of the canal by *lacunæ* provided for that purpose. At its bulbous part, the urethra takes a considerable curve forwards, and is surrounded in the rest of its course by a peculiar erectile texture, denominated the *corpus spongiosum urethræ.* This substance is expanded, at the extremity of the penis, into what is termed the *glans*, which is covered by a fold of the skin called the *prepuce.* The *corpora cavernosæ* are the cylindrical bodies which compose the chief bulk of the penis. They arise by two *crura*, one from each ascending ramus of the os ischii, and are chiefly composed of the peculiar structure, termed the *erectile tissue*, (see § 434.) At its extremity, the urethra is considerably narrower than where it passes along the corpus spongiosum.

(809.) These parts, namely, the glans and corpora cavernosa penis, and the corpus spongiosum urethræ, consist principally of large convoluted veins, which in the last named part are particularly dilated and branched, and are bound together and crossed in various directions by ligamentous bands and fibres. This arrangement, by obscuring the connexions which the veins have with one another, as well as their tortuous course, has led to the mistake that has so long prevailed among anatomists, of ascribing to these bodies a cellular structure. These bands appear to be provided for the purpose of limiting the distention of the vessels, and adding to the rigidity occasioned by the accumulation of blood in the venous convolutions during erection. The means by which the blood is made to pass from the small arteries into these convoluted veins, is not clearly understood. Professer Müller[2] has lately discovered a remarkable set of minute dilated and ramified branches, which he terms *arteriæ helicinæ*, and which are appended to the terminal twigs of the arteries distributed on the sides and interspaces of the venous cavities in the penis of man and several animals, and which he represents as projecting into the interior of the veins, and pouring their blood into them; a mechanism which must doubtless have some direct relation with the process of erection. Dr. Houston[3] has described some muscles, under the name of *compressores venæ dorsalis penis*, to the contraction of which, and the consequent impediment to the return of the blood from the penis, he attributes the erection of that organ. It is more probable, however, that this effect is produced principally by an altered action of the blood-vessels themselves, and is analogous to the turgid state of the vessels which occurs in blushing, than is owing to any mechanical cause. The purpose served by the dilatation, elongation, and rigidity of the male organ, effected by this vascular action, is obviously that of enabling it to penetrate to a sufficient distance into the female organs during coition, for the conveyance of the semen to those parts of the latter whose office it is to carry it on to the ovulum which it is intended to fecundate. With this view, the secretions from the testes, vesiculæ seminales, prostate gland, and the glands of Cowper, are poured together into the bulb of the urethra, and thence expelled with force by the action of the muscles called the *ejaculatores seminis.*

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[1] The whole length of the excretory vessels of the testes is very extraordinary. Their diameter has been stated to be no greater than the 200th part of an inch; and it has been estimated that the total length of the vessels which compose one of the testes amounts to more than 500 feet.

[2] *Archiv. für Physiol. &c.* 1835. pp. 27 and 220.

[3] *Dublin Hospital Reports*, vol. v.

ıe semen, d its ani- lcules.

(810.) The seminal fluid, which acts so important a part in the process of generation, has at all times attracted much attention. It is found to be considerably heavier than water, to have a peculiar odour, which increases on keeping; to exhibit alkaline properties, and to give off ammonia when heated. From the analysis of Vauquelin, it appears that human semen contains six per cent. of animal mucus, three of phosphate of lime, and one of uncombined soda; the rest being water. The phosphate of lime is deposited in crystals when the fluid is at rest. But the most remarkable circumstance in its composition is, the constant presence of an immense number of microscopic animalcules, the form, appearances, and size of which are different in almost every different animal; but in each species of the more perfect animals, the kind of animalcules, like that of the entozoa, is constant and determinate. Leeuwenhoek claims the merit of having first discovered them; but the priority of this discovery is assigned by Haller to Ludwig Hamm, who, when a student at Leyden, is said to have observed them in the year 1677. Another claimant of the discovery is Hartsoeker,[1] but apparently on no good grounds. An account of the controversy that arose on this subject, is given by Dr. Bostock.[2] Doubts were at one time entertained of the fidelity of the representations of these singular beings given by Leeuwenhoek; but they have been wholly removed by the later researches of Spallanzani, and the still more recent inquiries of Prevost and Dumas. These animalcules have a definite figure, consisting of a flattish rounded head, from which proceeds a long tail, exhibiting constant undulatory movements. They are accordingly classed by naturalists under the title of *spermatozoa*, as a species of the genus *cercaria*, among the infusoria.

(811.) It would appear from the elaborate researches of Prevost and Dumas, that these spermatic animalcules are found, at one time or other, in the semen of almost all the animals in which they have been sought for; but at that period of their life, and in that season of the year only, when the animals in which they exist are fit for procreation. They are almost always present in the fluid secreted by the testicles, and very often in that of the vesiculæ seminales, into which they have doubtless been introduced along with the fluid derived from the testicles. Hence it has been concluded, that their presence is intimately connected with the power of propagation; and may even be essential to that process. Wagner infers from his observations, that these animalcules are subject to remarkable changes of form at different periods, and that they even go through a regular gradation of developement; and phenomena leading to the same conclusion have been observed by Dr. Allen Thomson.[3]

ıberty in male.

(812.) It is not until the period of puberty that the generative organs are fully developed, and become capable in either sex, of exercising their proper functions. Prior to this period, the physical character of the two sexes is nearly the same: there is the same delicacy of complexion, the same high pitch of the voice, and the same slightness of figure. But the developement of the sexual organs appears to exercise a peculiar and specific influence over the system at large, affecting the growth of the rest of the frame, and modifying both its physical and mental powers. The attainment of this condition is more tardy, by two or three years, in the male than in the female; and the age at which it takes place, differs in different climates, and in persons of different temperaments, modes of life, and circumstances of physical and moral education. It occurs at an earlier age in southern than in northern climates; in this country generally appearing in the male between the ages of fifteen and eighteen years; and in the female from that of thirteen to sixteen; but in the hottest regions of the great continents, girls are said to arrive at puberty at ten, or even at nine years of age; and in the northernmost parts of Europe, not till that of from fifteen to eighteen. The arrival of this period is retarded by habits of active bodily exertion.

(813.) The characteristic changes induced by puberty in the male besides the developement of the genitals, and the secretion of the seminal fluid, are the enlargement of the larynx, which changes the quality of the voice; the growth of the beard on the chin, upper lip, and cheek, and of an increased quantity of hair on the rest of the body, and especially on the pubes; the enlargement of the chest and shoulders; an increase of physical activity and power; a greater capability of enduring fatigue; an exaltation of the active powers of the mind, and of the qualities of courage and resolution.

(814.) The act of sexual union is prompted by instinctive feelings, experienced by both sexes, and which generally depend on the condition of the body, and of the genital organs in particular, which are then in a state of high excitement. This mental feeling, and the local affection appear to be intimately associated together, and mutually produce one another. According to the doctrines of phrenology, the cerebellum is supposed to be that particular part of the encephalon which presides over the sexual function; and to be, in a word, the sensorium commune of the feelings relating to it; that is, the part to which impressions of a sexual kind proceed, and from which all sexual desire emanates; and to be the source of that power by which the generative organs execute their appropriate functions. Dr. Allen Thomson, after enumerating the proofs alleged in favour of this hypothesis,[4] observes, that he is not inclined to adopt it as established on sufficiently accurate and extensive data; and remarks, that the comparative anatomy of the brain, (in which, rather than in experiments on animals, he would be disposed to place much reliance, from the acknowledged difficulty of making correct deductions as to function, from the effects of morbid alteration or artificial injury of the encephalon,) affords very few arguments in favour of the phrenological doctrine, and furnishes several facts which militate strongly against it. (See the article PHRENOLOGY.)

SECT. IV.—*The Female System.*

Female generative organs.

(815.) The female generative system of organs, having to perform the offices of receiving, conducting, and applying to the ovulum the seminal fluid, of conveying the ovum into a situation where it can be evolved and properly nourished, and of bringing it forth at the appointed period into the world, is necessarily much more complicated and elaborate than the male system. The part performed by the male is quickly accomplished, while the female has to execute a long series of processes, which require a considerable time, and are connected with important changes in the economy.

(816.) The ovaria, of which we have already described the structure and offices, are connected with a hollow muscular organ, termed the *uterus*, *matrix*, or *womb*, by two ducts, called, from the name of the anatomist who first described them correctly, the *Fallopian tubes.* They commence by a trumpet-shaped mouth, opening from the abdominal cavity, and of which the edges are fringed or jagged with irregular filaments, or *fimbriæ*, as they are termed.[5] The mouth of the Fallopian tubes are endowed with the power, on certain occasions of venereal excitement, of attaching itself to the adjacent ovarium, and of firmly grasping it. The tubes, each of which is about five inches long, in their progress towards the uterus, soon contract in their diameter, and become exceedingly narrow at their termination in the upper and lateral corner of the triangular cavity of that organ. They are enclosed in the folds of the peritoneum which form the broad ligaments of the uterus.

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[1] *Essai de Dioptrique*, art. 88, p. 227.

[2] *Elementary System of Physiology*, p. 642, note.

[3] *Cyclopædia of Anatomy and Physiology*, art. Generation, p. 460.

[4] *Cyclopædia, &c.* p. 444.

[5] This part has also been termed the *morsus diaboli.*

(817.) The uterus itself is a compact, dense, membranous, and fleshy organ, provided with a copious supply of blood-vessels, lymphatics, and nerves. It has the shape of a flattened pear, and is situated in the pelvis, between the rectum and the urinary bladder. The outer surface of the uterus is covered with a reflected portion of the peritoneum, which, in passing from the sides of the uterus to the sides of the pelvis, forms the broad ligaments already mentioned, or the *Alæ Vespertilionis*, as they have been called. It is also provided with round ligaments, connecting it with the external parts of the pubes. The inner surface of the uterus is lined with a mucous membrane. The existence of muscular fibres in its substance has been called in question by many anatomists, and it is certainly difficult to demonstrate their presence; yet the extraordinary mechanical force which this organ exerts during parturition can scarcely be ascribed to any power but a muscular one.[1] The parts of the uterus are distinguished into the *fundus*, which is the broad end turned towards the abdomen, the body and the *cervix*, or narrow end. The channel of the cervix uteri, which proceeds from the lower angle of its triangular cavity, leads into the *vagina*, which is an elastic membranous canal, opening externally, and surrounding at its upper part the cervix uteri, which forms a protuberance in its cavity, called the *os uteri*, or *os tincæ*, from its supposed resemblance to the mouth of a tench.

The membrane which lines the vaginal cavity is continued from the mucous membrane of the uterus, but is thrown into numerous folds and wrinkles, admitting of occasional dilatation of the canal. This is surrounded by a tissue, of an erectile structure, termed *plexus restiformis*, or *corpus cavernosum vaginæ*.

(818.) The external parts are the *mons veneris*, which is formed by an accumulation of adipose substance on the upper part of the *symphysis pubis*. Below this are the *labia pudendi*, forming in their progress towards the anus, from which they are divided by the *perinæum*, what was called by the French anatomists *fourchette*. Between the labia is the *fossa magna*, in the upper part of which is lodged the *clitoris*, a small, round, and spongy organ, which is analogous to the penis in its erectile structure, being composed of two *corpora cavernosa*, arising from the tuberosities of the os ischii, and terminating in an impervious glans, furnished with a prepuce. The *meatus urinarius*, or orifice of the urethra, which in the female is very short, opens immediately below the clitoris. From this part, on each side of the fossa, extends the *nymphæ*, or *labia minora*, which are membranous and spongy folds. The *vulva*, or orifice of the os externum, is in part closed by a transverse membrane, of a crescentic form, called the *hymen*, the remains of which, after it has been lacerated, compose the folds called *carunculæ myrtiformes*.

Puberty and menstruation.

(819.) The changes which the female system undergoes at the period of puberty are on the whole as considerable as those of the male, although many of the external characteristics of the state of childhood are still retained, such as the delicate texture and inferior developement of the general frame, the large proportion of subcutaneous fat, smooth skin, and want of prominence in the muscles of the trunk and limbs. But the genital system undergoes a considerable and rapid developement at this period, the breasts enlarge, the pelvis becomes more capacious, and a peculiar periodical secretion, from the inner surface of the uterus, consisting of a certain quantity of sanguineous fluid, is established. This process, which is termed *menstruation*, recurs at periods nearly equal to a lunar month, and continues, with certain intermissions, determined by the occurrence of pregnancy, and the performance of the function of lactation, as long as the organs are capable of bearing progeny, which is, on an average, a term of thirty years. The fluid thus discharged is generally believed to contain less fibrin than blood, and to be less prone to putrefaction; it evidently contains a large proportion of the colouring particles of the blood, and is very seldom found to coagulate. The secretion amounts, on an average, to six or eight ounces, and usually continues for about four or five days, beginning and leaving off gradually, and being most abundant towards the middle of the period. The discharge in general takes place slowly, or drop by drop.

Conception.

(820.) The effectual fecundation of the *ovulum*, which is by this change converted into an *ovum*, and its removal to a situation where the *embryo*, then first brought into existence, can be perfectly developed, constitute the process of *conception;* but the exact nature of this process, as well as the precise circumstances which must concur for its successful accomplishment, have been but very imperfectly ascertained. The investigation of these phenomena in the lower animals, however, has rendered it extremely probable that Graafian vesicles are continually being produced in the ovarium, and come forwards at intervals, during the whole period of female fertility, and that they burst in succession, and shed the contained ovula, whether sexual intercourse take place or not, although there is reason to believe that their maturity is hastened by this act. The consequence of the bursting of one of these vesicles is the escape of the ovulum or ovum, as the case may be, and its passage down the Fallopian tube into the cavity of the uterus. The lacerated membrane of the vesicle closes, leaving a scar; the internal coat becomes thickened, and a yellow substance is deposited in its cavity, giving rise to the appearance which has been termed a *corpus luteum.* The presence of this substance is a certain indication of the previous bursting of a Graafian vesicle.

Corpus l teum.

(821.) Much discussion has arisen on the question as to the precise time when, and place where, the ovulum is impregnated. There seems now, however, little reason to doubt that the semen, immediately on its reception into the uterus, is conveyed by the Fallopian tubes to the ovarium itself, and then comes in contact with the exposed ovulum, which is ready for fecundation. On the bursting of the vesicle, the ovum is conveyed down the Fallopian tube, and arrives at the uterus, where the changes it next undergoes will be the subject of future inquiry.

SECT. V.—*Theories of Generation.*

Hypothe ses.

(822.) Having thus stated the provisions which have been made by nature for the fecundation of the ovulum, by the concurrent offices of the two sexes, we may here examine various speculations and opinions which, from time to time, have been entertained relative to the nature of this marvellous and mysterious process; speculations which, although for the most part exceedingly hypothetical, and often completely visionary, have been dignified with the appellation of *theories of generation.* This it is our intention to do very briefly, and to notice only the more important of these theories; for the total number of hypotheses which have been advanced on this subject is so great, that their mere enumeration might occupy many pages. Drelincourt, who lived in the latter part of the seventeenth century, collected from the writings of his predecessors as many as two hundred and sixty-two "groundless hypotheses" concerning generation; and "nothing is more certain," observes Blumenbach, "that Drelincourt's own theory formed the two hundred and sixty-third"

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[1] Dr. Bostock has given in his *Physiology* an enumeration of the authors who have written on both sides in this controversy, p. 648, note.

(823.) These theories may be arranged according as they relate to the action of the parent organs, or to the changes in the egg occurring during the formation of the new animal; and Haller divided the first of these classes into three divisions, according as the offspring is supposed to proceed; first, exclusively from the organs of the male parent, which is the theory of the *Spermatists;* or, secondly, entirely from those of the female, which is that of the *Ovists;* or, thirdly, from the union of the male and female products, which is the theory of *Syngenesis.* The second class, again, may be arranged under two heads, according as the new animal is supposed, first, to have its parts rendered visible, by their being expanded, unfolded, or evolved from a previously existing though imperceptible condition of the germ, which is the theory of *evolution;* or secondly, to be newly formed from amorphous materials at the time when it makes its appearance in the ovum, which constitutes the theory of *Epigenesis.*

Of the erma- s.

(824.) The theory of the *Spermatists* regarded the male semen as furnishing all the vital parts of the new animal, the female organs merely affording the offspring a fit receptacle and suitable materials for its nourishment, until it could exist by the independent exercise of its own functions. One of the earliest supporters of this hypothesis was Galen; but its modern revival dates from the period of the discovery of the seminal animalcules, which were regarded by Leewenhoek as the proper rudiments of the fœtus. They were even considered by some to be miniature representations of men, and were styled *homunculi;* one author going so far as to delineate in each, the body, limbs, features, and all the parts of the grown human body. Even Leewenhoek describes minutely the manner in which they gain the interior of the ovum, and are retained after their entrance by a valvular apparatus.

Of the ists.

(825.) The Ovists, comprising some of the older philosophers, such as Pythagoras and Aristotle, maintained that the female parent affords all the materials necessary for the formation of the offspring, the office of the male being merely to awaken the dormant formative powers residing in the female products. Malpighi and Harvey asserted that the rudiments of the fœtus are derived principally from the female ovum; an opinion which was also elaborately defended by Vallisneri.[1]

Of Syn- esis.

(826.) The theory of *Syngenesis,* or of the simultaneous combination of products derived from both sexes, which after sexual intercourse, are supposed to unite together to form the germ, is also of very ancient date. In connexion with this theory may be mentioned that modification of it which may be termed the theory of *metamorphosis,* according to which a formative substance is held to exist, but is allowed to change its form, in order to be converted into the new being; as also the hypothesis of Buffon, which was eagerly adopted by Needham, who conceived that certain molecules which they termed *organic,* and which they believed universally to pervade plants and animals, were all endowed with productive powers, which enabled them, when placed in suitable situations, to attract one another, and to compose by their union living organized bodies. They imagined, that in the process of generation the superabundant portion of these organic molecules were accumulated in the generative organs, and there constituted the rudiments of the offspring.

Of evo- tion.

(827.) The hypothesis of *evolution,* or of pre-existing germs, coincides with that of the Ovists, in considering the fœtus as solely the production of the female; but it farther assumes that it already exists, with all its organs, in some part of the female system, previous to the sexual intercourse; and that it receives no proper addition from the male semen, the action of which is merely that of exciting the powers of the fœtus, and of endowing it with vitality. The observations of Haller with respect to the gradual enlargement or evolution of the chick during the process of incubation, were conceived to lend great support to the advocates of this theory, of whom the most strenuous and enthusiastic was Bonnet. This naturalist, so celebrated for the boldness of his speculations, contended, not only that the whole of the parts of the fœtus pre-exist in the ovum, before they actually make their appearance, but that the germs of all the animals which are in future to be born, also pre-exist in the female parent; so that the ovaries of the first parents of any species of animal, contained the germs of all their posterity, included the one within the other, like a nest of boxes; from which comparison he termed his theory that of "*emboitement.*" This extravagant notion was adopted by many physiologists, principally from its affording some kind of explanation of what no other theory seemed in the least adequate to solve. Spallanzani, in particular, was a zealous defender of the hypothesis of pre-existing germs. It appears, however, to be totally irreconcileable with the phenomena of hybrid productions, and of the resemblance which, in so many instances, the offspring bears to its male parent.

5. Of Epigenesis.

(828.) We have already mentioned that Harvey and Malpighi ascribed the formation of the fœtus principally to the powers of the female. This opinion gave origin to the modern theory of *Epigenesis,* first clearly promulgated by Caspar Frederick Wolff,[2] who not only described a successive production of organs, of the previous formation of which there existed no trace; but showed also, that after parts are first formed, they undergo many important changes in their shape and structure, before arriving at their finished state. The more recent researches, aided by delicate microscopical observation, of Meckel, Pander, Baer, Rathké, Oken, Purkinje, and Valentin; Serres, Rolando, Dutrochet, Prévost and Dumas, Coste, and others, have demonstrated that the theory of Epigenesis, or superformation of parts, is much more consistent with the observed phenomena than that of evolution. The facts which have thus been brought to light, are of peculiar interest with reference to the plans of nature, into which they give us a more extended insight, by exhibiting new and unexpected affinities between remote families and classes of animals; by showing that at one period the type of their formation is nearly the same, and by explaining the seeming caprice of nature in instances of monstrous and defective formation. But to attempt adducing the proofs and illustrations of these positions, would engage us into details requiring an extensive survey of the whole animal creation, to enter into which would occupy more space than is compatible with the limits of the present treatise. We must, therefore, content ourselves with referring, for more ample elucidation of this subject, to the Bridgewater Treatise *on Animal and Vegetable Physiology.*[3]

Sect. VI.—*Utero-Gestation.*

Utero-gestation.

(829.) On the arrival of the ovum in the cavity of the uterus, to which we have traced it in a preceding chapter, the first object of nature is to effect its attachment to a portion of the inner surface of that organ. A provision for this purpose has already been made, even while the ovum was contained in the ovarium. A vesicle, first noticed and described by Dr. Barry, is formed around the ovum; the granules of the *tunica granulosa* become less densely aggregated together, and gradually pass into the state of fluid albumen; oil globules appearing for the first time to take their place on the surface of the ovum. This fluid he supposes to correspond to the yolk of the eggs of birds; and the membranous vesicle above mentioned, in which it is enclosed, and which thus forms after impregnation, he considers as the rudimental chorion, by which the ovum is afterwards attached to the uterus.

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[1] *Della Generazione,* part 2.

[2] In his inaugural dissertation, entitled *Theoria Generationis,* published at Berlin in 1759.

[3] Part iv. chap. ii. on *Organic Developement;* and chap. iv. on *Unity of Design.* Vol. ii. pp. 599, 625.

(830.) It results from these views, that mammalia differ from oviparous animals in the circumstance, that those parts of their ovum which are last formed, have a more internal origin; thus, the first portion of the albumen and the chorion of the ovum in mammalia, originate, not in the oviduct, but in the ovary; for which purpose, chiefly, there is provided the very large quantity of albuminous fluid in the Graafian vesicle; a provision which may be presumed to have especial reference to the development of the embryo within the body of the mother. The chorion, being formed in the ovary, it is an *ovum*, and not an *ovulum*, that is expelled from that organ in mammalia. On the other hand, in birds it is an *ovulum*, and not an *ovum*, that leaves their ovary; and it becomes an ovum, and receives an addition of the albumen, or yolk, and the shell membrane in their oviduct, and then becomes analagous in all its parts to the ovum of the mammal when the latter leaves the ovarium. The albumen, in the form of granules, lines the ovisac, constituting the *membrana granulosa;* and in the form of the *flake* it supports the ovulum in the centre of the fluid of the ovisac, and afterwards supports it at the periphery of the latter, sometimes in the form of the *petasiolus granulosus*, or *cumulus* of Baer. It closely invests the ovulum in the form of the *tunica granulosa;* it forms, in the rabbit at least, and probably in other mammalia, two bands or ligaments, termed the *chalazæ*, which are conspicuous in birds; and finally, it also provides the granulous bands by which, in some instances, too sudden a discharge of the ovum of the Graafian vesicle is prevented.

(831.) Dr. Barry finds that the ova of the rabbit of five or six days, when in the uterus, are in bulk about eight thousand times that of the ovulum in the ovary, and have three concentric membranes; namely, first, an outer vesicle, (the villous chorion,) originating in the ovary; secondly, the primitive membrane of the yolk, distended so as to fill the chorion; and, thirdly, an inner vesicle, or membrane, which has been called the *blastoderma*, or germinal membrane, presenting in its substance a central spot, which is the germinal spot, or *embryo*. Dr. Allen Thomson has seen this spot very evident in the ova of a rabbit, on the sixth day after impregnation. It corresponds exactly with the part called the *cicatricula* in the egg of a bird, which there lies immediately on the surface of the yolk, imbedded in a disc of granules. In the centre of the cicatricula, a dark round spot is seen, termed the *colliquamentum*, which contains a minute vesicle, discovered by Purkinje, and which bears his name. This vesicle, which is seen in the ovulum, afterwards bursts, and leaves in its place a thin and tender transparent membrane. In the centre of this transparent spot, may be perceived, seven or eight hours after the commencement of incubation, with the aid of a magnifying glass, a small dark line. This line, or *primitive trace*, as it has been termed, is swollen at one extremity, and is placed in the direction of the transverse axis of the egg. The rounded end is towards the left, when the small end of the egg is turned from us.

(832.) Having traced thus far the changes occurring in the ovum before it becomes attached to the uterus, we shall defer the consideration of the subsequent stages of its evolution to a future section, and here attend to the changes which have in the mean time taken place in the uterus, with a view to prepare it for the office it has now to perform.

Placenta.

(833.) A change has already taken place in the uterus, preparatory to the reception of the ovum, and before its arrival in that cavity. An increased flow of blood is directed towards that organ. A substance consisting of lymph, or organizable fibrin, exudes from its interior surface, furnishing it with a soft flaky lining, which, when the ovum is received, is reflected over that body, so as to give it a double covering. These two folds, the one being in contact with the uterus, and the other with the ovum, constitute the two layers of the *membrana decidua;* the former portion being termed the *decidua vera*, and the latter, the *decidua reflexa.* This membrane soon becomes organized, and highly vascular. The vessels in the progress of growth, are in some parts much dilated, so as to form sinuses, which are ultimately intermingled, though by no means continuous, with the blood-vessels of the fœtus. These latter blood-vessels, consisting of the umbilical arteries and veins, of which the trunks are collected in the umbilical cord, have passed to the chorion, which by the end of the first, and during the second month of pregnancy, has acquired a villous external surface. At the end of this period, the branches of these vessels penetrate and ramify in these villi, which become thoroughly vascular; and this thickening and vascularity is concentrated on one side of the chorion, generally on that which is adjacent to the fundus of the uterus, forming the body called the *placenta.* This body is of a flattened oval shape, from six to eight inches in breadth, and from an inch to an inch and a quarter in thickness at the middle part, becoming thinner towards the edges. It occupies about a fourth part of the chorion, and at birth is about a pound in weight. In ruminant quadrupeds, the substance corresponding to the human placenta, is confined to a number of circular and spongy elevations, varying in number from thirty to one hundred, which are termed *cotyledons.* The human placenta is evidently formed of a structure essentially the same, composed of many lobes consolidated by contact into one organ. It has been very generally supposed that the placenta is of a cellular structure, and that the arteries and veins of the uterus communicate with its cells; but the late researches of Dr. Robert Lee,[1] renders it very doubtful if these inter-placental cells really exist.

(834.) In proportion as the fœtus grows, the uterus enlarges, and about the fifth month it rises out of the pelvis, and rests against the front of the abdomen. As it enlarges, the distinction between the body and the cervix is lost; the os tincæ is flattened, and forms only a small rugous hole, not easily discernible; and it is closed by a tough glutinous matter, which is fixed in the irregularities of the surface.

SECT. VII.—*Parturition.*

Parturition.

(835.) The ordinary period of utero-gestation is forty weeks; on the expiration of which the uterus takes on itself a new kind of action; its contractility, which had lain dormant for so long a time, is now suddenly and powerfully excited. A mucous discharge takes place from the vagina, the external passage is relaxed, and slight pains are felt in the back and loins, which usher in the real pains of labour. These are occasioned by powerful contraction of the uterus, accompanied by a strong action of the diaphragm and abdominal muscles; and they are repeated at short intervals. Impelled by this pressure, the membranes of the fœtus project into the vagina, and dilate the os tincæ; on their bursting, the liquor amnii escapes, and at the next pain the pressure of the uterus falls directly on the fœtus. The head of the fœtus gradually descends, urged on by succeeding spasms, the occiput foremost, the long axis of the head being disposed obliquely across the lesser basin of the pelvis. The occiput, as the external parts yield, glides off the inclined surface of the ischium, presenting at the orifice of the vulva, and bringing at the same time the long diameter of the shoulders to correspond with the greatest breadth of the pelvis, and the head being thus disengaged, the trunk follows. After a short time, fresh pains return, and the placenta and membranes being detached from the uterus, comes away. In the majority of natural births, labour is completed in from four to six hours. The uterus then very slowly and insensibly contracts, so as to diminish the ample cavity which has been rendered vacant, and at the same time its volume is reduced by absorption. During the return of the uterus to its former state, a discharge, at first tinged with blood, and afterwards of a whitish colour, termed the *lochia*, ensues, which lasts for several days.[1]

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[1] *Philosophical Transactions* for 1832.

SECT. VIII.—*Lactation.*

tation.

(836.) The function by which nourishment is prepared, of a nature suited to the early periods of infant life, belongs to the reproductive class of functions. The fluid provided for this purpose is the *Milk*, of which we have already examined the chemical properties, and noticed the qualities which peculiarly fit it for the purpose it is intended to serve. The organs which prepare it are the *mammæ*, which are glands consisting of the union of a great number of lobes, intermixed with adipose substance, and remarkable for the whiteness and fineness of their texture. The numerous excretory tubes from these lobules unite in forming ducts, which open separately in the folds of the integuments of the nipple. A remarkable sympathy is observed between this gland and the uterus; for it often enlarges and becomes tender for a few days before each monthly period. It enlarges during the latter months of pregnancy, and the brown circle surrounding the nipple, or *areola*, as it is called, assumes a darker colour. The secretion of milk would naturally continue until the middle of the second year, if the child were retained at the breast as long as it was supplied. During the period of suckling, the menstrual discharge is not renewed, but pregnancy may, however, again take place, before its recurrence.

SECT. IX.—*Fœtal Evolution.*

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(837.) In judging of the changes which take place in the human embryo from the period when its evolution commences, we must be guided principally by those which, occurring in the developement of that of the chick, furnish the best means of following the whole succession of phenomena. Commencing the inquiry, then, from the appearance of the primitive trace in the blastoderma, or cicatricula, already described, (§ 831,) we find this part gradually dilating in bulk, and occupying a situation between the two layers, namely, the outer and the inner, into which, towards the twelfth or fourteenth hour of incubation, this cicatricula has divided itself. The outer of these layers is called by Pander the *serous layer;* and it subsequently gives rise to the nervous, the muscular, the osseous, cartilaginous, and tegumentary systems of the body. The innermost, which is situated in contact with the yolk, is the *mucous layer*, whence are derived the alimentary canal, and the glandular and pulmonary systems. A third layer, (the *vascular layer*,) is afterwards formed in the interval between the two former, and is the origin of the sanguiferous system of the fœtus, including the heart and all the blood-vessels. The respiratory system is the product of the combined changes which this, together with the last mentioned layer, undergoes.

(838.) The series of phenomena which present themselves in following the succession of changes occurring during the formation of the vital organs, are highly curious, and afford the most splendid instances of that refined intelligence and that provident adjustment of a long series of means for the effectual accomplishment of future and far distant ends, which strike us with profound astonishment when we penetrate into the remoter regions of physiology, removed from ordinary observation. It would far exceed the limits within which we must confine ourselves in the present treatise, to give the detailed history of these organic changes. We must content ourselves, therefore, with a brief outline of the principal phenomena, and with referring to works professedly treating on this subject, for more copious information on this highly curious department of physiology.[2]

(839.) On the outer surface of the serous layer, or that most distant from the yolk, there are raised two parallel ridges, which, joining along their upper margins, form a canal; in this canal, according to Baer and Serres, a semi-fluid matter is deposited; this matter, acquiring consistence, becomes the spinal chord, with a pyriform extremity, which last is the rudiment of the future head. Roland, Prévost, and Dumas, on the other hand, suppose that the primitive trace is itself the spinal cord and brain, in their rudimental state.

Rudimental intestine.

(840.) When the layers of the germinal membrane have so far expanded as to cover nearly one-third of the yolk, they no longer retain their flat and uniform appearance, but begin to exhibit various folds, which afterwards become the different cavities of the body. Those of the mucous layer turn downwards, and whilst its remote expansion includes within it the yolk, as in a sac, the inner folds close inwards, and by the union of their margins form two tubular cavities, one at each end of the embryo, communicating in the middle with each other, and also, by a common opening, with the cavity of the yolk. This tube is the nascent alimentary canal.

Vascular area, and heart.

(841.) The first rudiment of the heart is perceptible at the anterior part of the vascular layer, which, as we have already stated, is developed between the serous and mucous layers. In the mean time, the surrounding disc of the cicatricula, which continues to expand, exhibits, in the circumference of the transparent area, which now becomes thicker and more spongy, numerous irregular points and lines of a dark yellow colour. These lines gradually extend, unite together, first into small groups, and then into one net-work, which composes the *vascular area*. The space they occupy is terminated, on each side, by a circular vessel, of larger size than the rest, the *sinus* or *vena terminalis*, into which the smaller ramifications of the vessels open at the circumference, whilst towards the central part they unite into a vessel on each side, the two *omphalo-meseraic arteries*, which penetrate into the vascular layer of the embryo.

Of the spinal cord and brain.

(842.) Simultaneously with these changes, all the important organs of the body are formed in rapid succession. The spinal cord and brain, of which we have noticed the first traces, are quickly developed; the former, appearing first as a membranous tube, the latter, as three vesicular bodies; and both being gradually filled with opaque nervous substances of two kinds, the one being uniform, the other filamentous. The nerves next appear, but whether they are generally formed in their entire length at once, or are growths from the brain or spinal cord, or are first produced at their farthest extremity, and afterwards extended towards the central organ, are points not yet determined. Some, however, as the optic, auditory, and olfactory nerves, are certainly productions from the cerebrum. The muscles become visible in the human embryo at the third month; they are then soft and gelatinous, transparent, of a light yellow tint, and not distinguishable from their tendons. Each muscle is formed at once in its whole length, with its attachments perfect. The eyes are formed at a very early period, and their growth is rapid; they are situated at first at the sides of the head, as in quadrupeds, and subsequently move forwards. The iris has no central aperture, the place of the pupil being occupied by the *membrana pupillaris*, which disappears completely before birth. The organ of hearing is formed soon after the eye. The substance of the bones is at first an homogeneous jelly, enclosed in a membrane, and exhibiting no divisions into joints. This jelly gradually becomes cartilaginous, the conversion taking place from the surface inwards. It is gradually replaced by ossific matter, which grows from the interior, resembling a process of crystallization. Ossification begins in the human embryo in the seventh week.

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[1] The above account of parturition is for the most part extracted from Mr. Mayo's *Outlines of Human Physiology*, as presenting a very clear and compendious account of the phenomena.

[2] The reader will meet with much instruction on these subjects, in Dr. Allen Thomson's papers on *Embryology* in the *Edinburgh New Philosophical Journal;* in the *Cyclopædia of Anatomy and Physiology*, by Dr. Todd; and also in Mr. Mayo's *Outlines of Human Physiology*, chap. xv. sect. ii. We would also beg to refer to the summary contained in the Bridgewater Treatise *on Animal and Vegetable Physiology*, vol. ii. p. 599. The greater part of the summary given in the present article is abridged from Mr. Mayo's work.

Of the skin and limbs. (843.) The integument is the outermost fœtal product of the serous layer, which gradually spreads like a mantle over all the other structures, and does not acquire proper strength till the middle of the fœtal period. At the end of the fifth month the body is covered with short, whitish, and silky down, which, however, disappears in the seventh month. The hair of the head and of the eye-brows, and the nails, are formed in the sixth month. About the fifth month there appears on the body a yellowish-white greasy substance, at first thinly, and afterwards more thickly spread, and termed the *vernix caseosa*. The limbs are formed originally below the skin, which they reach, pushing out like little globular shoots, in the sixth week. They originally grow straight out from the trunk. The upper arm is next laid against the breast, the fore-arm drawn upwards; the thigh is bent up to the belly, the leg drawn backwards towards the thigh, and the feet turned in, and crossed, with the soles turned inwards. When the fingers are first formed, they are contained in a common mitten of skin, which, gradually becoming thinner between them, forms a web, which is finally absorbed.

Amnios. (844.) Another product of the serous layer is one still more external than the integument of the fœtus, and consisting of a sac formed by a membrane reflected from the sides and from either extremity of the embryo, so as to enclose a space behind its body. This is the *amnios*, which forms a loose bag filled with a liquid *(the liquor amnii)* in which the fœtus floats, suspended by the umbilical cord. As the walls of the trunk close in front, the circular edge by which the amnios is attached to the body of the embryo becomes proportionably contracted; and it is finally limited to the umbilical opening, hereafter to be noticed.

The communication which we described as being left between the intestinal tube and the cavity of the yolk bag, or *vitelline sac*, and which in birds continues open, soon becomes closed in mammalia, the sac assuming the form of the *intestinal vesicle*, discovered as such by Bojanus in the ovum of the sheep; though it had been before seen and known by the name of *vesicula alba;* it disappears by the third month.

Glands. (845.) The glandular organs which communicate with the alimentary canal are formed by the extension of its mucous membrane in the form of tubular productions, shooting into small masses of matter lodged in its neighbourhood; the blind ends of the tubes being often dilated into spherical pouches. The gall bladder is, in like manner, formed by the extension of a tube, which not being received into a mass of elementary matter, enlarges into a simple sac.

Lungs. (846.) The lungs are regarded as another expansion of the mucous layer of the germinal membrane, growing from the back part of the œsophagus, and gradually advancing on either side of the aorta, so as at length to surround it.

Kidneys. (847.) The kidneys are preceded in the embryo by a substance first noticed by Wolff, and called after him the *Wolffian bodies*, or *false kidneys*, which originally extend the whole length of the spine, from the heart to the end of the intestines; but they become afterwards shorter, and, after a time, diminishing by absorption, wholly disappear. They appear to be subservient to the developement both of the true kidneys and of the testes and ovaria. The bladder and urethra, on the other hand, together with the external genitals, are formed partly out of a developement of the extremity of the intestine, and partly by fissure and folding of the integument, in the following manner.

Allantois. (848.) There is first the production of a bag of considerable length, called the *allantois*, from the intestine, or that part of it which may be considered as the *cloaca;* subsequent contractions of the sides of this sac, at different parts, next divides it into two cavities, the proper allantois and the urinary bladder; and the lower contraction is elongated into the canal of the urethra. The separation between the two former afterwards closes, and the coalesced membrane forms the ligament termed the *urachus*. The urethral tube never closes.

Genitals. (849.) The testes and ovaries appear in mammalia about the same time at the inner and fore part of the Wolffian bodies, attached to them by a fold of the peritoneum. From each testis or ovary there descends to the internal ring a membranous process, which in the male is called the *gubernaculum*, and in the female constitutes the *round ligament.* It passes, in either sex, along the spermatic passage to the filamentous tissue of the scrotum or labium. The ovaries descend to the brim of the pelvis; the testes pass through the ring into the scrotum.

Blood-vessels. (850.) Every organ begins to be formed without either blood, or blood-vessels; the circulation in them being established solely for the purpose of subsequent growth and perfection. Even the heart is formed and shaped, and its texture has acquired some degree of consistency, and it displays an undulatory motion, before the blood has reached it. We have already described the formation of vessels and of blood in the vascular area; but the blood is at first motionless. It afterwards finds its way from thence by the omphalo-mesenteric veins to the heart, whence it is expelled along the aorta, and thence again carried into the vascular area; thus establishing a simple circulation. In a few days arterial branches extend from the aorta, and venæ cavæ are formed, establishing the systematic circulation. Five pair of branchial vessels are formed from the aorta in the neck, the œsophagus being between the branches on each side, and there are also four openings in the neck of the embryo on each side. This single heart, branchial arches, and openings, are permanent parts of the structure in fishes. In the mammalia, these branchial clefts soon close; the heart becomes separated by the growth of partitions in each ventricle and auricle, into two separate cavities, and the artery is divided, in like manner, into an aorta and pulmonary artery. Some of the arches then disappear; others become permanent aortic, and others permanent pulmonary branches; and the fœtus is becoming prepared for pulmonary respiration.

Umbilical cord. (851.) The amnios, closing upon the shrunk urachus, forms with the umbilical artery and veins, and a connecting gelatinous tissue, the *umbilical cord*, or navel-string; connecting the fœtus with the placenta, which, as we have before seen, is formed by a thickened portion of the chorion. The umbilical vein distributes part of its blood to the liver, and then, under the name of the *ductus venosus*, joins the inferior cava, through which the mixed blood of the placenta and of the inferior part of the body is carried into the right auricle of the heart. Part of this blood passes directly from the right to the left auricle through the *foramen ovale*, which is an aperture in the yet imperfect septum of the auricles; the remainder, with the exception of the small quantity transmitted to the yet imperfectly developed lungs, passes from the pulmonary artery, through the *ductus arteriosus* directly into the aorta. The offices of the placenta are supposed to be those, first, of introducing nourishment, transmitted by imbibition from the maternal to the fœtal blood, through the membranes of the interjacent vessels of the mother and the fœtus; and, secondly, of oxygenating the blood of the fœtus by imparting to it oxygen from the same source. It has been supposed by many that the fœtus derives sustenance from the liquor amnii which surrounds it, and which might be introduced through the mouth into the stomach; but this opinion is now very generally abandoned. It is true, however, that the stomach of the fœtus usually contains a considerable quantity of ropy mucus, but without albumen. This last substance is found in the contents of the duodenum,[1] and the great intestines contain a green matter termed *meconium*, which has the appearance of being the refuse of a kind of digestion. It has been conjectured that the *thymus gland* has some relation to the function of fœtal assimilation.

CHAP. XIX.—PROGRESSIVE CHANGES IN THE ANIMAL ECONOMY.

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(852.) We have now traced the history of the changes which the human system undergoes, from the earliest rudimental state in which it exists in the embryo, through the period of its fœtal life, to the epoch of its birth; when it is ushered into the world, with organs fitted for maintaining a comparatively independent existence, yet still requiring the most tender offices and most fostering care of that parent, of whose system it had so long formed a part, and from which it has been so recently dissevered. To follow the narrative of the successive alterations which take place during the growth of the system, the proportional developement of its several organs, and the acquisition of its various powers, both corporeal and mental, during all the subsequent epochs, filling up the interval between the cradle and the grave, composes a long chapter in human physiology, and would occupy too large a space for the present treatise. All that we can pretend to attempt must be a faint sketch of the outlines of this "strange eventful history."

(853.) The greatest of all the changes which occur in the animal existence of every human being, is its emergence from the state in which it was dependent for its immediate supply of nourishment and of oxygen on the blood which is circulating in the vessels of its parent. On its birth, which cuts off the placental circulation, all these ties are at once dissevered. A new element surrounds it, from which it is in future to derive the principle that maintains its vital energies. The placental supply is superseded by respiration; and the first gasp of air received by an instinctive effort into its lungs alters at once the whole character of its organic constitution. It is now a breathing animal; and all the channels and passages, which had till then been adapted to a different mode of being, have now become useless, or rather worse than useless, and they must give way to a new order of processes, and a new mechanism of the hydraulic functions. The ductus venosus, the foramen ovale, and the ductus arteriosus are superseded in their functions, and must be speedily closed and obliterated, in order to give place to new courses of circulation and a new order of functions.

(854.) Besides these changes, which, being consequent on the sudden exercise of the new function of respiration, are immediate, the whole organization rapidly conforms itself to the great alteration of the circumstances in which it is now placed. As the growth of the fœtus had been progressively becoming more and more rapid in proportion as the term approached when it was to be ushered into the world; so, on the other hand, the growth of the body is greatest in the earliest periods of its extra-uterine life, and becomes more and more slow in proportion as it advances to the full dimensions it is destined to attain. The principal anatomical changes which follow birth, besides those already stated, are the gradual obliteration of the thymus gland, and of the renal capsules.

(855.) The natural term of lactation is succeeded by that of teething; the first set of teeth, or the *milk teeth*, being furnished by nature as temporary structures, until instruments of greater dimensions can be constructed in the enlarged jaws. The appearance of the teeth is an intimation that the organs of assimilation are prepared for the digestion of solid food; and that the proper period for weaning is arrived.

(856.) From this period an accurate observer may perceive that the intellectual education keeps pace with the physical; whilst the active exercise of the limbs consolidates the bones, and gives firmness to the muscles, that of the senses is continually adding to the store of ideas, and calling forth the latent powers of the understanding. The moral faculties are developed much earlier than is generally imagined; and the future character of the individual often receives a permanent impress from the events of infancy. No one can have watched its varying aspect at this tender age, without recognising how early its affections are called forth towards its protector and fosterer; how quick is the distinction it makes between kind and unkind treatment, and how keen is its sense of the least injustice which it may have either to bear or to witness.

(857.) To the periods of infancy and childhood succeeds that of puberty, which we have seen is attended in either sex with remarkable changes, both physical and moral. During the period of increase the powers of assimilation are in full activity in furnishing a sufficiency of materials for growth; the circulation is vigorously employed in applying them to that purpose; and the supply is even more abundant than the consumption. When, however, the fabric has attained its prescribed dimensions, the total quantity of nourishment furnished and expended being nearly balanced, the vital powers are chiefly exerted in consolidating and perfecting the organization of every part, and qualifying them for the continued exercise, during a long succession of years, of those functions of which we have given the history in the preceding part of this treatise.

(858.) But, in the mean time, the process of consolidation, begun from the earliest period of developement, is still advancing, and is producing in the fluids both greater thickness, and a diminution of their total quantity. By the gradual conversion of their gelatin into albumen, all the textures acquire increasing solidity; the cellular substance becomes firmer and more condensed, and the solid structures more rigid and inelastic. The contractile power of the muscles is also impaired; and the limbs no longer retain the elastic spring of youth. All these progressive modifications of structure tend slowly, but inevitably, to disqualify the organs for the due performance of their functions. Their vascularity gradually diminishes; for a large proportion of the arteries which had been actively employed in building the fabric, being now thrown out of employment, contract, and, becoming impervious, disappear. The parts of the body, having acquired greater rigidity, oppose a gradually increasing resistance to the propelling force of the heart, which is itself, in common with all the other vital powers, slowly diminishing. The absorbents are now active in removing the parts which have become useless or superfluous. Old age steals on by slow and imperceptible degrees, which, even when obvious to others, are unknown to ourselves. But nature kindly smooths the path along which we descend the vale of years, and conducts us by easy stages to our destined place of repose. When death is the simple consequence of old age, we may perceive that the extinction of the powers of life observe an order the reverse of that which was followed in their evolution. The sensorial functions, which were the last perfected, are the first which decay; and their decline is found to commence with those mental faculties more immediately dependent on the physical conditions of the sensorium, and more especially with the memory, which is often much impaired whilst the judgment remains in vigour. The heart, the pulsations of which gave the first indications of life in the embryo, generally retains its vitality longer than any other organ; but its powers being dependent on the constant oxidation of the blood in the lungs, cannot survive the interruption of this function, and on the heart ceasing to throb, the death of every part of the system may then be considered as complete.[1]

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[1] See a paper by Dr. Robert Lee, in the *Philosophical Transactions* for 1829.

CHAP. XX.—TEMPERAMENTS.

Definition of temperament.

(859.) In the natural and healthy condition of the system, all its functions are nicely adjusted and proportioned to each other, so as to produce the most perfect harmony. Yet within the limits of health variations are admissible in this balance of functions, according as some predominate over others in regard to energy and activity; or rather, according as there prevails a tendency to such predominance, which, though it does not actually overset, may yet endanger the preservation of that balance which constitutes health, and may thus give at least a proneness to disease. This peculiar state of the system, depending on the relation between its different capacities and functions, by which it acquires a tendency to certain modes of action, is called its *Temperament.*

(860.) Much attention was paid by the ancients to the subject of temperaments; and the nomenclature they established to express the various combinations of peculiarities in the constitution, corresponding with the definition above given, has continued in general use even to the present day. They described four temperaments, corresponding to the four qualities of hot, cold, moist, and dry, ascribed to the human frame by Hippocrates, and which were supposed to confer the specific characters to the four ingredients of which the blood was thought to be composed; namely, the red part, the phlegm, the yellow, and the black bile respectively; and hence were derived the names of the sanguine, the phlegmatic, the choleric, and the melancholic temperaments, as indicating an excess of each of these principles.

(861.) In modern times the ancient doctrine of temperaments was adapted to the humoral pathology, by which all the deviations from the standard of health were attempted to be explained. Boerhaave, reasoning on these principles, and considering the several temperaments as being formed by different combinations of the four cardinal qualities, increased their number to the eight following: namely, the warm, cold, moist, dry, bilious, sanguine, phlegmatic, and atrabilious. Darwin, endeavouring to found his doctrine of temperaments on varieties in the vital actions of the system, which he had classified as referring to the four heads of irritation, sensation, volition, and association, formed four temperaments in conformity with this arrangement, in which these functions were conceived respectively to predominate.

(862.) Most of the modern physiologists, however, following the example of Cullen, have adopted the four temperaments of Hippocrates, which are characterized by the following peculiarities:

Sanguin

(863.) The *Sanguine* temperament is distinguished by a full habit and relaxed frame of body; by a greater vascularity, softness and delicacy of skin, in which the veins are of considerable size, and are particularly conspicuous by their blue colour, as seen through the thin layers of the skin. The surface of the body generally, and more especially the face, exhibits a florid and ruddy colour. The hair is generally of a light brown; but has often a yellow, and sometimes a reddish hue. Persons endowed with a sanguine temperament are acutely sensitive, and highly irritable: their pulse is frequent, indicating the general rapidity and energy of the circulation. Both the secretions and excretions are abundant, and little liable to obstruction. The disposition is free and open; the temper cheerful, and rather disposed to levity.

Melanc lic.

(864.) A remarkable contrast to the temperament just described is presented by the *melancholic* temperament, which is marked by a firm and robust frame, and a spare habit of body; by an integument of greater thickness, and of a brown and swarthy hue; and by an abundance of dark or black hair, which being particularly conspicuous in the eye-brows and beard, and being conjoined with a black colour of the iris, imparts to the countenance a stern and sombre aspect. In persons endowed with this temperament the pulse is habitually slower than the average condition; the blood is thicker and more sluggish; the secretions and the excretions are less copious, and more apt to be morbidly deficient than with the generality of men. The nervous system is, on the whole, less sensitive and excitable; but the mind, although not readily moved, when once set in motion, is remarkably retentive of its impressions, and tenacious of its purposes; persevering and indefatigable in action, ardent and constant in its affections; possessing great capacity of understanding, with a fondness for contemplation, and for speculative inquiries demanding profound thought. The temper is naturally grave, and often gloomy; the fancy imaginative, and of a poetic turn, but tinctured with melancholy, and betraying a proclivity to madness; when happily tempered, it exhibits that fortunate combination of genius and industry from which have resulted the noblest achievements of the human intellect.

Choleri

(865.) The *Choleric* temperament would seem to occupy a place intermediate between the two former, as partaking of some of the qualities of both. The frame is more relaxed, the senses more excitable, and the mind more irrascible than in the melancholic temperament. The complexion is less ruddy than in the sanguine temperament, and the pulse stronger and more frequent; the secretions are more copious, and the skin fairer and less hairy than in the melancholic temperament.

Phlegm

(866.) The *Phlegmatic* temperament is denoted by a relaxed and feeble frame, prone to obesity; a pallid complexion, a smooth integument, with but few hairs, that on the head being of a light colour. The circulation generally is languid, the pulse slow and weak, the blood-vessels less capacious, the fluids more bland and watery. The functions of digestion, secretion and excretion, are performed slowly, and are liable to frequent impediments. The mind is dull, sluggish, disposed to indulge in sleep; not easily moved, timid, inclined to fear, and prone to avarice.

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[1] For more ample details on the subject of the changes which take place in the progress of age, see the article AGE in the *Cyclopædia of Practical Medicine,* and also the chapter on the Decline of the System in the Bridgewater Treatise *on Animal and Vegetable Physiology,* vol. ii. p. 619.

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(867.) Dr. Gregory has added to these four temperaments a fifth, which he denominates the *nervous* temperament, and which owes its peculiarities to the sensibility of the nervous system existing in an undue proportion to the contractility of the muscles; conjoining the qualities of excitability and of debility. Such an union of qualities, however, is compatible with the characteristics of other temperaments, but occurs more commonly in the sanguine, whether existing in its purest form, or blended with the phlegmatic; and it is found exemplified chiefly among those whose occupations are sedentary, and who lead a life of ease and luxury.

(868.) These several temperaments are found variously modified by occasional intermixture in different degrees with one another. Thus, the phlegmatic is often conjoined with the sanguine, and sometimes with the melancholic temperaments; and observation will readily suggest examples of other similar combinations. The predominance of each of these temperaments varies at different periods of life. At an early age the system inclines more to the sanguine; in middle life, to the choleric; and at a more advanced age, to the melancholic temperament. They admit also of being variously influenced and modified by climate, habits, and education; and accordingly each is found to prevail amongst particular tribes and nations, and in particular regions of the globe.

CHAP. XXI.—VARIETIES OF THE HUMAN SPECIES.

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(869.) It has been a question much agitated amongst naturalists, whether the differences observable in the complexion, features, and the intellectual and moral endowments of different tribes and nations which are found scattered over the surface of the globe, are sufficiently great to mark an original diversity of species, or whether they correspond merely to the character of varieties taking place in a single original race, analogous to those we behold in many domesticated animals, such as the dog, the horse, and the sheep, and therefore affording no objection to the hypothesis that every individual composing the human race belongs really to one and the same species. To Blumenbach belongs the merit of being the first who entered with a philosophical spirit into the investigation of this great problem. The generally prevailing opinion at present is, that all mankind are the descendants of the same original stock; and are therefore to be considered as members of the same family.

arieties.

(870.) It is a matter of considerable difficulty to establish an accurate classification of the different varieties into which the human race should be divided. Blumenbach, who, from having devoted to it much labour and attention, is justly considered as the highest authority on this subject, has fixed the number of these varieties at five; though, as Mr. Lawrence observes, these five races ought perhaps rather to be considered as principal divisions, each of them including several subordinate varieties. M. Bory de St. Vincent, in his *Treatise on Man*, extends the number of primitive varieties to fifteen. Cuvier, on the other hand, is inclined to refer all the varieties in the race to three principal heads, considering the others as merely modifications of these.

(871.) The five varieties which Blumenbach has pointed out, are designated by the terms *Caucasian*, *Mongolian*, *Ethiopian*, *American*, and *Malay*. He regards the Caucasian race as the primitive stock, or as the standard and type of the rest. It appears, indeed, to occupy an intermediate place between the Mongolian race, on the one side, and the Ethiopian on the other, which latter races are the most widely different from each other. The American variety has been considered as intermediate between the Caucasian and the Mongolian; and the Malay race as intermediate between the Caucasian and the Ethiopian. The various intermixtures which have taken place between these several races, in different parts of the world, render it very difficult, at the present day, to draw those precise lines of distinction which have probably, in remoter times, characterized the primitive races now enumerated. Thus, in Asia, we find considerable mixtures of the Caucasian with the Mongolian races; whilst in Africa, the Caucasian race has in various instances been blended with the Ethiopian.

1. Caucasian.

(872.) The following are the circumstances by which these several varieties are characterized:—1. The *Caucasian races* are distinguished by the general whiteness of the skin; the fairer complexions exhibiting a roseate tint, particularly conspicuous in the cheeks, and derived from the abundance of blood circulating in the vessels, and the darker races inclining to a brown, and by the abundance and softness of the hair, which is either black, or of a lighter chesnut colour, occasionally inclining to red. The cranium is large and oval, and developed especially about the forehead; the face comparatively small, and falling perpendicularly underneath the forehead. The features are distinct from each other; the nose narrow, and frequently aquiline; the mouth small; the front teeth in both jaws have a perpendicular direction; the lips, particularly the lower one, are gently turned outwards; the chin is full and rounded, and the general contour of the face has an oval form, and is broader in the upper than in the lower portion. This is the race in which the moral and intellectual energies of man have risen to a higher degree of excellence than in any other; and it is the race which has at all times been the most susceptible of cultivation and improvement. The hope may indeed be entertained that it is yet far from having arrived at the highest point in these respects which it is destined to attain.

2. Mongolian.

(873.) 2. The *Mongolian* races are characterized by a complexion approaching to an olive colour; the eyes being black; the hair also black, strong, and straight; the beard thin and scanty; and the head of a form somewhat square; the cheek bones large and prominent; the forehead low; the face broad; the features flattened, and running together; the nose small and flat; the aperture of the eyelids narrow, and the orbits situated obliquely; the lips thick; the chin slightly projecting; the ears large. The stature of most of the nations belonging to this race is, in general, inferior to that of Europeans.

3. Ethiopian.

(874.) 3. The *Ethiopian* or *negro race* is marked by the lateral compression of the skull, which is elongated forwards; by the prominence of the cheek bones, the narrowness and projection of the jaws, and the recession of the chin. The forehead is low, and very slanting; the eyes prominent; the nose broad, thick, and flat; the lips, the upper one especially, thick; the upper front teeth are oblique; the hair black and woolly; the legs are long and slender; the calf especially is small, and the knees are bent inwards; the arms are longer than in the other races.

4. American.

(875.) 4. The *Aboriginal American race* is remarkable for the red colour of the skin, the strong and straight black hair, the scanty beard, and low forehead, the deeply sunk eyes, and the round and prominent cheek bones. The mouth is large, the lips thick, and the face in general broad and square; characters which assimilate this race with the Mongolian, from which, however, it is sufficiently distinguished by the colour of the skin, and the projection of the features, especially of the nose.

5. Malay.

(876.) 5. The *Malay variety* of the human species varies considerably in the colour of the skin, from a light tawny brown, to one approaching to black. The head is narrow; the bones of the face are large and prominent; the mouth large; the nose full and broad at the point. The hair is black, and more or less curling.

Their distribution.

The following account of the filiation of the different races, and of their distribution over the globe, is given by Cuvier.

(877.) The Caucasian race has been so named from its presumed origin in the western part of Asia, in the neighbourhood of the Caucasian chain of mountains, which are situated between the Caspian and the Black Seas; whence it has spread as from a centre to the adjacent parts of the Asiatic, European, and African continents. The present inhabitants of these regions, namely, the Circassians and the Georgians, are reputed to be still the handsomest race on earth. The principal ramifications from the primitive stock, may be most satisfactorily traced by following the analogies of the languages of the nations which have proceeded from it. Thus, the Armenian, or Syrian branch, proceeded southwards, and gave rise to the Assyrian and Chaldean nations; and also to the Arabians, who, after the era of Mahomet, aspired to the empire of the world. The Phœnicians, Jews, and Abyssinians may be regarded as Arab colonies, to which class also the Egyptians may probably be referred.

(878.) The branch giving origin to the *Indian*, *Germanic*, and *Pelasgic* tribes was far more widely spread, and became subdivided at a much remoter period of antiquity. Among the four principal languages which prevailed among the nations composing these races, namely, the Sanscrit, the ancient Pelasgic, the Gothic or Teutonic, and the Sclavonic, we may trace the most multiplied affinities. The primitive Sanscrit is still preserved as the sacred language of the Hindoos, and is the model on which all the existing languages of Hindostan have been formed. The Pelasgic is the primitive source of the Greek, of the Latin, and of many other tongues now extinct, but from which most of the present languages of the south of Europe have been derived. The Teutonic has given rise to the languages of the northern and the western nations of Europe, such as the German, the Dutch, the English, the Danish, the Swedish, together with their various dialects. From the Sclavonic tongue are derived those of the north-east of Europe, namely, the Russ, Polish, the Bohemian, and the Vendean.

(879.) It is amongst this latter extensive race that philosophy, sciences, and the arts, have been most assiduously cherished, and have been carried to their highest states of perfection. This race had, in Europe, been preceded by the Celtic tribes, which originally came from the north, and were formerly widely spread, but which are now confined to very narrow spaces in the west of Europe and Africa, and are nearly effaced by continued intermixture with the numerous races which have supplanted them.

(880.) The ancient *Persians* have a similar origin with the Indians; and their descendants at the present time, bear the strongest marks of affinity to the modern European nations.

(881.) The *Scythian* or *Tartaric* branch, first directed itself towards the north and north-east, and composed the wandering tribes which traversed the immense plains of Tartary. In later times, become more numerous, they returned to spread devastation amongst the flourishing establishments of their more civilized brethren. The irruptions of the Scythians in Upper Asia, of the Parthians, who overthrew the domination of the Greeks and Romans in those regions; of the Turks, who destroyed that of the Arabs, and reduced to subjection the miserable remnant of the Greek nations in Europe; all proceeded from the overflowings of the northern swarms from this common race. The Finlanders and the Hungarians, which belong to this race, may be regarded as stragglers from these swarms, amidst Sclavonic and Teutonic tribes. On the northern and eastern coasts of the Caspian Sea, the original cradle of these races, there are still found tribes which have the same common origin with the former, and which speak a similar language; but they are variously intermixed with a great number of other smaller tribes, differing from them both in language and in origin.

(882.) The *Tartarian* tribes have remained more free from mixture, along the whole of that extensive tract whence they long defied the power of Russia, but to which they have at length been forced to submit; namely, from the mouths of the Danube, to the countries beyond those of the Irtish. But the conquests of the Mongols have led to considerable blending of the two races among the Tartarian nations.

(883.) The *Mongolian* race inhabits the remoter regions of Asia, extending from the eastern parts of the continent, where the Tartar branch of the Caucasian race terminates, to the Eastern Ocean. The different branches of this Mongolian race, such as the Calmuc Tartars, and the Kalkas, have no settled residence, but are wandering tribes over the extensive deserts of Eastern Asia. Thrice have their ancestors carried far and wide the terror of their arms; first, under Attila; next under Genghis Khan; and, lastly, under Tamerlane. The Chinese are an ancient branch of this family, which was very early trained to a high degree of civilization; at a period, indeed, apparently more remote than that to which our most ancient histories extend. The Manchew Tartars, who have recently achieved the conquest of China, are a third branch of the same Mongolian race. The Japanese, the Coreans, and almost all the hordes which extend to the north-east of Siberia, under the dominion of Russia, belong also to the same division of the human species.

The original seat of this widely-spread race appears to be the chain of the Altai mountains, the central ridge of Asia; in the same way that the race to which we belong was derived from the inhabitants of mount Caucasus; but it is quite impossible to unravel the complicated filiation of these various tribes. The history of these wandering people is as evanescent as their establishments; and even that of the Chinese, confined as it is to the limits of their empire, supplies only brief and unconnected notices of the surrounding nations. The affinities of their languages are too imperfectly known to afford any clue for our guidance in this mighty labyrinth.

(884.) The languages of the north of the Indian peninsula, beyond the Ganges, as well as that of Thibet, have some relations with the Chinese language; at least they resemble it in their monosyllabic structure. There is also a general resemblance of features among all these Mongolian tribes. But the southern division of the same peninsula is inhabited by a different race, namely, *Malays*, distinguished from the former by their greater symmetry of form, and by a peculiar language. This race is spread over the coasts and islands of the Indian Archipelago, as well as those of the Southern Pacific. In the largest of the Indian Islands, however, we meet with a much more barbarous race of men, with dark woolly hair, with black skins, and with the negro features, and savage and ferocious in their dispositions. They are known by the name of *Papuans*, and are principally met with in the Islands of New Guinea, and the New Hebrides. It has been conjectured that this singular tribe was descended from negroes accidentally cast on the shores of these remote islands.

(885.) The inhabitants of the northernmost regions both of the old and new continent, comprising the Samoides, the Laplanders, and the Esquimaux, possess many peculiar features, and have been classed by some naturalists under the Mongolian races, but are considered by others as degenerated scions from the Scythian and Tartaric branches of the Caucasian race.

(886.) The aboriginal American Indians have never been satisfactorily assimilated to any one of the races of the ancient continent; yet they scarcely possess any precise or well marked distinctive characters, which may entitle them to be regarded as one of the primitive races of mankind. The copper hue of their skin is certainly not of itself sufficient to establish such a distinction. Their dark hair and scanty beard would incline us to refer them to the Mongolian race, were it not that their well defined features, and prominent nose, are opposed to such a classification. Their languages are as diversified as their tribes are numerous; and no analogy has yet been traced either amongst one another, or with any of those of the old world.

(887.) The analogy of what we observe in the inferior animals, affords the strongest grounds for believing that natural causes are perfectly adequate to explain the diversities which occur in the several varieties of the human race, on the supposition of their having originated from a common stock. The variations in size, colour, and even forms, which take place amongst different kinds of dogs, characters which are transmitted from the parent to the offspring with as much constancy as those of the human race, are no less considerable than the differences observable between the European and the negro, and yet are admitted by naturalists to be perfectly compatible with the unity of the species, and with a community of source. Of the causes which originally produced the peculiarities in the several varieties of the race, and which have become permanent, we can have no certain knowledge; nor can we even supply the want of precise information by any rational conjecture. The common hypothesis which ascribes the black colour of the negro to the more powerful influence of the solar rays in tropical climates, will not bear the test of close examination; no permanent effect of that kind having ever been produced by the same cause operating for any length of time on the complexion of Europeans. Different opinions have been entertained with regard to the natural and original complexion of the human race. Dr. Prichard contends that it was black, and that the Ethiopian form was the primitive type of the race; the successive changes produced being that from the imperfect to the more perfect form, and from barbarism to refinement; terminating at length in the Caucasian race, in which it has attained the greatest state of improvement compatible with its nature, accompanied by the highest degree of capability of civilization, and of intellectual and moral excellence.[1]

(888.) In opposition to the doctrine of the unity of species in all human races, it has been contended by Rudolphi, Virey, Desmoulins, Bory St. Vincent, and others, in the most positive manner, that these races were originally different. The arguments on each side of the question are fully discussed in the work of Dr. Prichard referred to.

CHAP. XXII.—COMPARATIVE PHYSIOLOGY.

(889.) We purpose, in giving an account of the most important facts relating to the physiology of the animal creation, to take as the standard of comparison the mode in which the functions of the human body are conducted. The history we have given of the animal economy in man will easily enable us to refer all the facts relating to comparative physiology to this standard type; and this view of the subject, besides the interest which naturally attaches to it, will have the further advantage of reflecting light on various subjects of human physiology, which, as we formerly remarked, must ever receive important elucidation from a comparison with that of the lower animals.

(890.) Conformably with this design we shall take a review of the different divisions of the animal kingdom; first pointing out the general characters of organization and of function which are common to each class and order; and noticing, in the next place, the peculiarities that are most worthy of remark in the several species included in those divisions. By thus following the logical order of descending from generals to particulars, we shall avoid the numerous repititions that would otherwise be requisite, and comprise in the smallest space the greater number of particular facts relating to the science.

Sect. I.—*Comparative Physiology of Mammalia.*

1. *Peculiarities in the Human Conformation.*

Peculiarities of the human structure,

(891.) Since man, in his zoological relations, must be comprehended in the class of mammalia, it is evident that the general characters of this class must consist of those possessed by the human species in common with quadrupeds, and even with the other families of mammalia still farther removed from man in their external conformation. While the points of resemblance are so numerous, the easiest mode of instituting a comparison between them will evidently be by pointing out, not the features which they possess in common, but those in which they differ. We shall begin then with an account of the peculiarities which distinguish the human structure from that of the lower animals, and more especially from that of the quadrumanous tribes, which approach the nearest to him in their conformation.

referable to mental endowments.

(892.) The great distinctive features which characterize the human conformation, as compared with that of all other mammalia, have reference to the superiority of his intellectual powers, and to his maintenance of the erect position. In the number and excellence of his mental faculties, and in his capabilities of improvement, he leaves all other animals behind by an immeasurable distance. The faculty of speech is a consequence of this developement of intellectual power, which is favoured, indeed, by the conformation of the larynx; but the organization requisite for the uttering of articulate sounds would have been in vain conferred unless it had been placed under the guidance of the mental faculties; thus to the parrot the gift of the organs of articulation, without the mind which is to use them as expressions of thought, becomes a comparatively unprofitable boon.

(893.) The superiority of the human intellect is accompanied by a much greater developement of the cerebral hemispheres than is found in any other animal. Hence also the great magnitude of the cavity in which it is contained, together with that part of the skull which protects it, when compared with the face, which is composed of the organs of the principal senses, and of the apparatus for mastication. The mass of the brain bears also a large proportion to the size of the cerebral nerves. The cerebellum is entirely covered by the hemispheres of the brain. The forehead in man is particularly distinguished by its elevation, and the beauty of its convex arch. The shortness of the lower jaw, and the prominence of its mental portion, are particularly remarkable. The elephant is the only quadruped in which the lower jaw is equally short in proportion to the size of the head; but this animal is still deficient in the projection of its lowest point, so that the possession of a chin seems to be peculiar to the human race.

Adaptation to the erect position.

(894.) In every particular connected with the mechanism of the fabric, man enjoys the most decided advantage over those mammalia which are most nearly allied to him in their physical conformation. Man is the only species amongst the mammalia whose body can maintain itself for any length of time in an erect position, and in whom the office of supporting the trunk is entrusted solely to the lower extremities. We find that every part of the osseous fabric, as well as the disposition of the principal organs of sense, are in obvious conformity with this design. The lower limbs, being the great instruments of support and progression, are larger, and of greater strength, compared with the body, than in most quadrupeds, the only exceptions being met with among those which are formed expressly for leaping, as the hare, the jerboa, and the kangaroo. In the monkey tribes the lower limbs are comparatively much weaker than in man;

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[1] See his *Researches on the Physical History of Mankind.* Third edition. London, 1806.

and in other quadrupeds the disproportion is still greater, the thigh bone being short, and almost concealed by the muscles which connect it with the trunk of the body, while the rest of the limb is very slender, and not covered by any considerable mass of muscle. In man the articular surfaces of the knee-joint are very broad, and admit of greater extent of motion than in quadrupeds, and the two portions of the limb can be brought into the same straight line, thus constituting firm perpendicular columns of support for the body. The long neck of the thigh bone allows of more complete rotation of the limb at the hip-joint; and this, together with the greater breadth of the pelvis, which affords an ample basis for sustaining the trunk, are circumstances peculiar to the human frame. The heel in man forms a greater projection than in other animals; and by its being extended so as to touch the ground, it forms, as we have seen, one of the points of support, by which, in conjunction with the toes, a much larger base is comprehended. The muscles which raise the heel, and which compose the calf of the leg, are of greater size and strength than in monkeys, besides acting with the mechanical advantage arising from the long lever which the heel affords for the insertion of their united tendons; and by the direction of the foot, which forms a right angle with the leg.

(895.) The form of the chest exhibits similar differences. In quadrupeds the thorax is compressed laterally, and is deepest from the spine to the sternum; a structure which allows the front legs to come nearer together, and to support with more effect the front part of the trunk. But in man the thorax is flattened anteriorly and extends more in width, that is, from side to side, thus throwing out the shoulders, and giving a more extensive range to the motions of the arms.

(896.) That the erect posture is natural to man is strongly indicated by the position of the head with respect to its articulation with the spine, which takes place at the middle of its basis; and thus, by the great extension of the occiput, its weight is more nearly balanced than it is in the monkey. The cervical vertebræ of the monkey have very long and prominent spinous processes, evidently adapted to give greater purchase to the muscles sustaining the head, of which the front part considerably preponderates, in consequence of the elongation of the jaws, and the backward position of the centre of motion.

(897.) The same design may be traced in the position of the eyes, the mouth, and the face in general; and is so obvious as to have been noticed by Ovid, while describing the formation of man, in the following celebrated lines:

> "Pronaque cum spectant animalia cætera terram,
> Os homini sublime dedit: cœlumque tueri
> Jussit, et erectos ad sidera tollere vultus."

(898.) All the internal organs have been regulated by the same intention. The human heart is placed obliquely in the chest, and rests by a flat surface on the diaphragm, to which its investing membrane, the pericardium, is firmly attached. In quadrupeds, no such attachment exists; but the heart is situated more perpendicularly with the apex directly downwards, and cannot be felt, as in man, striking on the left side of the ribs at each contraction of the ventricles.

Arm and hand.

(899.) The fore legs of quadrupeds are in general appropriated solely to the support and progressive motion of the body. In some instances, indeed, they are employed, besides, in other actions; such as seizing and securing their prey, raking and digging up the earth, or climbing and laying hold of the branches of trees; but it is only in a few species, and chiefly among the monkey tribes, which resemble man in their form, that they are instrumental in carrying food to the mouth, or even in grasping weapons of offence. But in man the superior extremity being entirely released from the office of maintaining any portion of the weight of the trunk, is at liberty to be employed for a great variety of purposes; and the exquisite structure of the human hand, which has already been noticed, renders this exemption of still greater value, and constitutes unquestionably one of the great perfections which mark the human structure, as compared with that of the brute creation. The arm and head are thus rendered an organ at once of prehension and of touch, for both of which purposes it is admirably adapted by the great latitude and variety of movements it is capable of executing. One of the chief sources of perfection in the hands is the structure of the thumb, which is furnished with muscles of so great a power, compared with those of the fingers, as to enable it to oppose and balance their united strength. Hence it is enabled to grasp a spherical body, and to retain firm hold of many objects, which otherwise could not have been held without the united efforts of both hands. This conformation is peculiar to man; for the paw of a monkey cannot exercise the same force and readiness of prehension, in consequence of the thumb being inferior in strength to the other fingers.

Vocal organs.

(900.) The great perfection of the organs which modulate the voice and produce so great a variety of articulate sounds, is another striking instance of the high destination to which the human structure has been adapted. In those tribes of monkeys which come nearest to the human conformation, the power of uttering articulate sounds is prevented by the interposition of two sacs connected with the larynx, which receive part of the air when the animal uses any effort to expel it from the lungs.

Man omn vorous.

(901.) The structure of the digestive organs in the human species is similar to that of many quadrupeds, and has generally been regarded as intermediate between that of the carnivorous tribes, and of those that live altogether on vegetable food. Man may very justly, and almost exclusively be entitled to the appellation of an omnivorous animal; being equally capable of subsisting on different kinds of aliment; and also of using at the same time a great mixture of different sorts of food. No other animal is capable of so great a versatility of powers in this respect. It has also been remarked, amongst the characteristic circumstances of the human race, that whilst other animals are contented with food in the state in which nature offers it, man alone employs artificial processes for improving its flavour, and rendering it more fit for digestion. Man is the only animal that is known to practise the art of cookery; an art which indeed appears necessary to enable the stomach to extract from his usual food all the nutriment it is capable of yielding.

(902.) The teeth of man are distinguished from those of all the other mammalia by their being arranged in either jaw, in a uniform unbroken series; and also by the circumstance of their being all of the same length. The cuspidati, or eye-teeth, as they are called, which correspond to the canine teeth in quadrupeds, are, perhaps, at first a little longer than the others, but their sharp points are soon worn down to a level with the rest. In all the monkey tribes, these teeth are long and prominent, and are separated by an interval from the neighbouring teeth. The cutting teeth in the lower jaws slant backwards in the monkey, and the jaw itself has the same direction; but in man these teeth are perpendicular, and in a line with the front of the jaw, which descends to form the prominence of the chin, a part of the face which does not exist even in the orang utan. The tubercles on the surface of the grinders are different in their shape, both from the ridges of enamel on the crowns of the teeth of herbivorous animals, and from the sharp-pointed eminences on the grinders of carnivorous animals.

Encephalon.

(903.) The human brain is not only larger in its relative proportion to the body than in any other of the mammalia, but its absolute size is greater, if we except only that of the elephant, and of the whale. With these few exceptions, all the larger animals with which we are more commonly acquainted, have brains absolutely, and even considerably smaller than that of man. Besides the prodigious expansion of the hemispheres, we may remark in the human brain a more elaborate structure, and a more complete developement of all its minuter parts. There is no part of the brain found in any animal, which does not exist also in man; whilst several of those which are found in man are either extremely small, or altogether absent in the brains of the lower animals. Soemmerring has enumerated no less than fifteen visible and material anatomical differences between the human brain and that of the ape. The proportion of medullary to cortical substance is greater in the human brain than in that of other animals.

icial gle.

(904.) Although the negro race is a branch of the great family of man, and although the peculiarities which distinguish the conformation of that race rank only as varieties in the species, it yet cannot be denied, that in almost every one of the circumstances in which it differs from the type of the Caucasian race, it exhibits an approach to the structure of the monkey or quadrumanous tribe of animals. In nothing is this approximation more remarkable, than in the proportion between the size of the face as compared with that of the brain. One of the most convenient methods of roughly estimating this proportion is that invented by Professor Camper. Drawing a line from the most prominent part of the frontal bone, to the anterior point of the upper jaw bone, just at the roots of the incisor teeth, which is called the facial line, it is to be intersected by another line, drawn from the external orifice of the ear to the inferior edge of the aperture of the nostrils. The angle formed by these two lines is the *facial angle* of Camper, which determines by its magnitude the degree of preponderance of the bones of the cranium, in which the brain is contained, over those of the face, which contain the organs of sense.

(905.) In man the facial angle is greater than in other animals; it differs, however, in different varieties of the human race, and appears to indicate with tolerable exactness the comparative degree of intellectual excellence appertaining to each variety. In the Caucasian variety the facial angle is between 80° and 90°; in the Mongolian, 75°; in the American Indian, 73½°; in the Negro it is only 70°. Pursuing the application of this test to the lower mammalia, we find it in the orang utan reduced to 65°; in the baboon, 45°; in the mandrill, one of the most ferocious of that tribe, only 30°. The mastiff has a facial angle of 41°, the bulldog of 35°. In the feline tribe it is still farther diminished; being only 28° in the leopard. In the sheep and hare it is 30, in the horse it is only 23°.

(906.) The varieties in the magnitude of the facial angle have thus been traced through a number of gradations amongst different tribes of mammalia and also of birds, till we arrive at its almost total obliteration in the snipe and the woodcock, animals which are reputed to be extremely deficient in intelligence.

(907.) The projection of the bones of the face, which tends to diminish the facial angle, is universally considered as expressive of stupidity or ferocity. An ample and projecting forehead, on the contrary, is associated in our minds with the idea of superior intelligence. It was probably for that reason that the owl was selected by the Athenians as the emblem of wisdom. In the statues of their divinities, the Greek sculptors have exaggerated the facial angle, making it as much as 100°, which is considerably greater than it is ever found in the human form. The Italian painters, also, in their representation of saints, have often given them a facial angle of 95°.

(908.) But in applying this method to some of the most sagacious species of animals, such as the horse, which, as we have seen, has a very small facial angle, we meet with great and striking exceptions. We arrive at more correct determination of the proportional developement of the face and brain, by comparing, as proposed by Cuvier, the areas respectively occupied by each in a longitudinal vertical section of the head. But in the elephant all these criteria, but especially the admeasurement by the facial angle, fail, in consequence of the great projection of the frontal bones, which are raised to a considerable distance from the brain by the interposition of large cells, or frontal sinuses, and which give an undue proportion to the size of the forehead.

Occipital angle.

(909.) Daubenton proposed, for the comparison of different skulls with one another, what he called his *occipital lines;* the one passing from the posterior margin of the great occipital foramen through the lower edge of the orbit; the other, taking the direction of the opening itself, beginning at its posterior edge, and touching the articular surface of the condyles. The angle formed by the intersection of these lines is his *occipital angle.* But the variations of this angle are too inconsiderable to furnish sufficient criteria of the character of the head.

2. *Peculiarities in the Conformation of other Mammalia.*

Mammalia in general.

(910.) The bones of quadrupeds appear, as Blumenbach observes, to possess a less fine and delicate texture than those of man. Their fibres are more easily loosened by maceration, and are of a coarser grain; this is more particularly observable in the jaw-bones and the ribs.

Spine.

(911.) The spine is formed of the same classes of vertebræ as in man, namely the cervical, dorsal, lumbar, and sacral. In all quadrupeds belonging to the class of mammalia, the number of cervical vertebræ is constantly seven, as in man. The length or shortness of the neck has no influence on their number, though it has a material one, of course, on the comparative length of each individual vertebræ. The cameleopard, whose neck is extended to so great a length, and the mole, in which it is so short, have each of them seven cervical vertebræ. An apparent exception to this general rule occurs in the three-toed sloth, in which Cuvier found nine vertebræ of the neck instead of seven; but it has since been found that the two last of the cervical vertebræ, which appeared to be supernumerary, ought properly to be classed amongst the dorsal vertebræ, of which they possess the distinctive characters.[1]

(912.) The number of dorsal vertebræ depends principally upon that of the ribs, which differ in different quadrupeds, and are usually more numerous than in man. Their transverse and spinous processes are generally longer than in man, for the purpose of affording a broader surface of attachment to the powerful muscles which support the head and neck.

The number of the lumbar vertebræ is various in different quadrupeds. There are only three in the elephant; five in the ass; six in the horse; and seven in the camel. Still greater differences are met with in the number of component parts of the sacrum.

Caudal vertebræ.

(913.) Most quadrupeds have a prolongation of that part of the skeleton which corresponds to the os coccygis of man, and which in them composes the tail, and consists of a great number of imperfectly formed vertebræ.

Skeleton.

(914.) The thorax of quadrupeds is, as we have already noticed, more compressed laterally, but deeper from the spine to the sternum, than it is in the human skeleton. The scapula is constantly found; but in most tribes there is no clavicle whatever, and in others only a short rudiment of that bone, connected merely with the muscles. In other respects the number and connexions of the bones of the extremities are generally very similar to the human conformation; we may observe, however, that the os femoris is usually much shorter than the tibia, and being covered by the large muscles which attach it to the trunk, appears to belong to that division of the body. The bones of the carpus and tarsus, together with those of the fingers, are in many cases exceedingly compressed, and some of them are so consolidated together, as not to be distinguishable as separate bones.

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[1] See a paper by Mr. Thomas Bell, *Philosophical Magazine*, third series, iii. 376.

Intermaxillary bone.

(915.) In all the mammalia we find a peculiar bone, called the *intermaxillary bone*, interposed between the two upper jaw-bones, and locked in between them; its office appears to be to contain the upper incisor teeth, when these teeth exist; but it is also met with when there are no incisor teeth.

Teeth.

(916.) The number, form, and internal structure of the teeth is exceedingly diversified in the different tribes; and afford excellent characters for the distinction of orders and genera of the class mammalia. As these characters have a strict relation to zoological classification, we shall abstain from entering here into the details of this subject.

(917.) In proceeding to notice the peculiarities of structure in the mammalia, we shall next examine the organs of the functions of assimilation, to which that part of the skeleton we have just adverted to, namely, the jaws and teeth, are subservient.

Digestive organs.

(918.) The tongue of quadrupeds is, for the most part, more narrow, long, and slender than that of man. Except in the genus simia, we do not meet with any structure corresponding to the uvula. The œsophagus has two layers of muscular fibres, which have a spiral course, and cross one another. This structure gives it greater power of propelling its contents into the stomach; a power which is the more required, inasmuch as the food has often to ascend considerably in passing along this canal.

(919.) The conformation of the stomach presents very considerable diversities, apparently determined by the habit of the animal and the nature of its food. From the simple structure it exhibits in the purely carnivorous tribes, we may observe a gradually increasing complication as we pass to those that feed on fish, and on vegetable aliment. In the latter orders of mammalia, and especially in the ruminants, we meet with a very complicated apparatus for digestion. But these diversities will come more properly to be noticed in the examination of the orders and families to which they relate. It will be sufficient here to remark, that the stomach is often divided into several distinct portions, such as the cardiac and pyloric; and often presents several intermediate subdivisions, and expansions into separate pouches, so as to exhibit the appearance of a multiplicity of cavities or stomachs. They differ also considerably as to the degree in which the glandular structures attached to their coats are developed in different parts.

(920.) Similar varieties are met with in the structure of the intestines of different mammalia. As a general rule, to which, however, there are several exceptions, it may be remarked, that the intestinal canal is much shorter, and more contracted in its diameter, in carnivorous animals than in those which feed on vegetables. This probably depends on the more rapid assimilation of animal than of vegetable materials; the latter requiring a more complicated apparatus, more capacious cavities, and a more extensive surface both for secretion and absorption. It has been observed that the canal of the intestines is longer in the domesticated breed than in the wild animal of the same species. Thus, in the wild boar, the length of the intestines is to that of the body in the proportion of nine to one; but in the tame animal the proportion is as thirteen to one. In the domestic cat it is as five to one; in the wild cat as three to one. It may also be remarked that in the class mammalia, the comparative length of the intestinal canal is greater than in any of the other vertebrated classes; and diminishes successively as we compare it in birds, reptiles, and fishes.

(921.) The liver in the mammalia generally, is divided into a greater number of lobes, and the divisions penetrate deeper into its substance, than in man. In a great many instances, as in the horse and the goat, there is no gall-bladder, the bile being carried at once by the hepatic ducts into the intestine. Occasionally when the gall-bladder is present, there exist also hepato-cystic ducts which convey the bile directly from the liver into the gall-bladder, and not by a retrograde course, as in man.

The mammalia is the only class of animals provided with omentum, which, in some, as in the racoon, is particularly large and stored with fat.

Kidney.

The kidney generally presents a lobulated appearance; sometimes to such a remarkable degree, as to bear a resemblance to a bunch of grapes, being composed of numerous small and distinct portions, connected together by their blood-vessels and excretory ducts. The urinary bladder is more capacious in herbivorous than in carnivorous quadrupeds.

Heart.

The heart of the mammalia corresponds in every essential particular of its structure with the human conformation; but it differs in its position with regard to the other organs, being situated more longitudinally, and resting on the sternum, which is below it, and not on the diaphragm, as in man. Hence, also, the direction of its axis is not so oblique, and it is placed more in the centre of the chest; and the pericardium is scarcely at all connected with the diaphragm.

(922.) In many quadrupeds the thoracic duct is double, and forms more distinctly than in man the enlargement which has been termed the *receptaculum chyli*. The mesenteric glands are frequently collected into a considerable mass, called the *pancreas of Asellius*.

Sensorial functions.

(923.) From the consideration of the organs of nutrition we pass on to those of the sensorial functions, and shall for this purpose revert to the osteology, in as far as relates to the bones which protect the brain and principal organs of the senses.

(924.) The divisions of the cranium of quadrupeds into separate bones, differs but little from that of the human skull. The os frontis is frequently found divided into two lateral portions by the prolongation of the sagittal suture forwards to the root of the nose. Sometimes, again, the sagittal suture is obliterated by the consolidation of the two parietals into a single bone; in other cases, these bones are united with the occipital. We often find, also, a bone, distinct from the temporal, termed the *tympanic bone*, provided for containing the tympanum of the ear. But it may be observed, in general, that the sutures present fewer indentations, and less irregularity in their course in the skulls of quadrupeds than in man, a circumstance which is naturally explicable by the smaller developement of the brain, and consequent diminution of the general size of the cranium. From the position of the head in the quadruped the occipital foramen is situated less anteriorly in the basis of the skull than in man, and is for the most part nearly vertical in its position. The tentorium sometimes contains within the laminæ of the dura mater which compose it, several strong plates of bone, and the same thing has also been observed in the falx.

(925.) The brain of quadrupeds is considerably smaller, when compared with the size either of the spinal cord or the cranial nerves, than in man. The cerebral hemispheres are also much smaller compared with the cerebellum. This arises in a great measure from the absence of the posterior lobes of the brain, which, in man, when viewed from above, conceals the cerebellum; whereas in quadrupeds the cerebellum is brought immediately into view in removing the upper bones of the skull. In the proper quadrupeds the anterior lobes of the brain extend forwards into two large processes, called the processus mamillares, which give origin to the olfactory nerves, and which contains a cavity on each side, communicating with the lateral ventricle, being in fact its anterior prolongation. On the other hand, this ventricle has no posterior prolongation, there being no posterior lobe.

rgans of ell.

(926.) Every part of the organ of smell is developed in quadrupeds in a degree corresponding to the greater extent and acuteness in which they enjoy this sense, compared with man. The æthmoid bone is much more complicated in its structure, as well as larger in its dimensions; the turbinated bones are considerably larger, more intricate in their formation, and present a much more extensive surface, being composed either of a great multitude of arborescent laminæ, or of numerous spiral convolutions. The internal nasal cavities are also generally enlarged, and particularly the frontal sinuses.

earing.

(927.) The organ of hearing also frequently presents a greater complication of structure than in man. A cavity, called by Soemmerring, the *bulla ossea*, communicates with that of the tympanum, and corresponds with the mastoid cells in the human subject. In the aquatic mammalia the external meatus is furnished with a valve for the purpose of excluding water from the passage. In these animals, also, as well as in those that live under ground, the external ear is altogether wanting. The structure of the internal parts of the organ agree in all essential points with those of the human ear. The cochlea sometimes makes an additional turn in its spiral convolution.

ision.

(928.) The eyes of mammalia exhibit considerable variety as to the position of their axes with respect to the general direction of the head. They are generally separated to a greater distance, and directed laterally. The figure of the globe is nearly spherical, as in man; but in several quadrupeds the sclerotic coat is much thicker and firmer at its posterior than at its anterior part. The choroid coat is distinctly divisible into two layers, of which the internal bears the name of the *tunica Ruyschiana*, and which often exhibits at the back of the eye the most brilliant colours. This coloured portion of the choroid is known by the name of the *tapetum*.

(929.) Several quadrupeds have an additional lacrymal gland, besides that which corresponds to the one in man; and also another gland, situated near the nose, and termed the *glandula Harderi*. The globe of the eye in quadrupeds is also provided with an additional muscle, the *suspensorius oculi*, for the purpose of supporting its weight. Many quadrupeds also possess a third, or internal eye-lid, called the *nictitating membrane*, which is very large and moveable in the cat, and all the animals belonging to the same genus.

egu- nts.

(930.) The panniculus carnosus is a muscular expansion, situated immediately under the skin, and subservient to the movements of the integuments, which it suddenly corrugates and throws into wrinkles, thereby driving off insects, or shaking away any other offensive matter, is peculiar to quadrupeds, not being found in man; unless the platysma myoides of the neck be considered as a muscle having an analogous function with relation to the skin of the neck.

(931.) In many quadrupeds some of the sebaceous glands of the integuments are very much developed. In some predacious animals, a gland exists in the orbit, described by Nuck, and of which the excretory duct opens near the last tooth of the upper jaw. It appears referable to the class of salivary glands. Another gland, particularly noticed by Professor Jacobson, and of which the use is wholly unknown, is generally met with in the anterior and lower part of the cavity of the nostrils: this he has called *the nasal gland of Steno*.

3. *Quadrumana.*

adru- na.

(932.) We have already had occasion, when describing the distinctive marks by which the human structure is characterized, when compared with that of the monkey, to point out several circumstances which are deserving of notice in the anatomy of this tribe of mammalia. Of all the animals of the family of the quadrumana, the orang-utan (*simia satyrus*, Geoff.) is that species which makes the nearest approach to the human conformation. This approximation is observable in the position of the great occipital foramen of the skull, which is placed farther forwards than in other kinds of apes; in the distinctness and serrated form of the sutures of the cranial bones; in the absence of the intermaxillary bone; in the eyes being directed forwards; in the smallness of the os coccygis, composed, as in man, of five imperforated bones; in the possession both of a cœcum and an appendix vermiformis; and in the oblique position of the heart with respect to the cavity of the thorax.

(933.) A still more remarkable peculiarity of structure in the orang-utan is that discovered and described by Camper; namely, two membranous sacs, which communicate with the glottis, and deprives the animal of the power of giving utterance to sounds.

(934.) In other species of this order we trace still further deviations from the human structure. The laryngeal sacs are found in many species of baboons; these are either single or double, and communicate with the larynx by openings between the os hyoides and the thyroid cartilage. The simia seniculus, and the simia beelzebub, have a large dilatation of the middle of the body of the os hyoides, which is expanded into a spherical bony cavity. This cavity, instead of interfering with the sonorous vibrations, adds to their strength, and gives the power of producing those loud intonations which are peculiar to this tribe, and from which they have obtained the name of *howling apes*.

(935.) The mandrill baboon has seven instead of five lumbar vertebræ. The appendix vermiformis of the cœcum is not met with in many species of apes. The crest of the occipital bone, though very large in the baboon of Borneo, is scarcely perceptible in most monkeys. The central foramen of the retina discovered in the human eye by Soemmerring, has been seen in the eyes of many animals of this order.

(936.) In the lemur tardigradus, and in the sloth, a singular structure has been observed by Sir Anthony Carlisle, with regard to the distribution of the arteries of the limbs. The trunks of these arteries suddenly subdivide as they enter the limb into a great number of parallel branches, which are again re-united when they arrive at the remote end of the first division of the limb; that is, about the joints corresponding to the elbow and the knee in man. After their re-union into single trunks, these arteries proceed to ramify in the usual manner.

4. *Chiroptera.*

Chiroptera.

(937.) In the bat tribe we have to notice the strictly hinge-like nature of the articulation of the lower jaw with the skull, which limits its motion to mere opening and shutting, and excludes all lateral movements. The zygomatic arches are expanded and raised, so as to allow room for the large and powerful muscles which close the jaw. The parietal bones are united into a single bone. The sacrum is composed of four bones consolidated together. Four clavicles are met with, and they are of extraordinary length. The ulna is deficient in the fore-arm, or exists only in a rudimental state, as a slender sharp-pointed process of the radius. The phalanges of the anterior extremities are enormously lengthened for the purpose of supporting the thin membrane which is stretched between them, and which serves the office of wings. The tongue of the bat is covered with sharp-pointed horny papillæ.

Vampire bat.

(938.) The vespertilio noctula is remarkable for the shortness of the intestinal canal, which is only twice the length of the animal's body. In the vampire bat, on the contrary, and in the vespertilio caninus it is seven times as long. In all bats, not only is the appendix cœci vermiformis wanting, but also the cœcum itself. The epiglottis is also wanting in most of the animals of this tribe. In many the tongue is slender, and prolonged into an organ of suction. The pectoral muscles are of enormous size; and the sternum has a prominent crest for the purpose of affording an extensive surface for their attachment. The eye is remarkably small; but the imperfections which probably exist in the sense of sight are amply compensated by the singular acuteness of that of hearing, the organ of which is exceedingly developed; and also by the extreme sensibility of the expanded membranes of the wings, which is such as to enable the bat to direct its flight through the most intricate passages without the aid of the sight, and without striking against obstacles purposely placed in its way.

5. *Insectivora.*

Insectivora. Mole.

(939.) Among the animals arranged by Cuvier in this family, the mole presents the most remarkable peculiarities of conformation, both as regards the skeleton and the internal organs. The sternum has the same crested process as in the bat, and apparently with the same design of enlarging the surface of attachment to the powerful muscles employed in digging. But the anterior extremity of this crest is still farther prolonged into a sharp process, having the figure of a plough-share, which is situated under the cervical vertebræ, and resembles the keel-like projection we shall have occasion to notice in the sternum in birds. The cervical vertebræ are remarkable for having no spinous processes. The ligamentum nuchæ is particularly strong, and is almost wholly ossified. The clavicle is of a singular shape, being nearly cubical. The humerus is very slender in the middle, and remarkably expanded at both its extremities. The fore-paw is provided with a bone of a peculiar shape, called the falciform bone, placed at the end of the radius. The phalanges have numerous processes, and are furnished with sesamoid bones; structures which, by giving considerable mechanical advantage to the muscles that move them, contribute greatly to increase their power. The great muscles of the trunk, the pectoralis major, the latissimus dorsi, and the teres major, are of great size, and give the animal great facility in digging the ground, and throwing up the earth as it proceeds.

(940.) The æthmoid bone is of very complicated formation in the mole, especially in the numerous convolutions of its turbinated processes, by which a very large surface is given to the Schneiderian membrane which lines every portion. This structure indicates the possession of a very acute sense of smell. The remarkable developement of the internal parts of the ears, is also conclusive evidence of the delicacy of the sense of hearing in this animal, although it has no external ear whatever. The eye is so minute, that even the existence of that organ has been denied by some naturalists; it is, in fact, not larger than the head of a pin. The cavities in which they are placed are so very superficial, as scarcely to deserve the name of orbits. The zygoma is not arched, but straight, and as slender as a thread.

6. *Plantigrada.*

Plantigrada.

(941.) Animals of the plantigrade family have a long but narrow intestinal canal, unprovided with any cœcum or appendix, and consequently not presenting any marked distinction between the small and the large intestines.

Bear.

(942.) To this family belongs the bear, remarkable for possessing supernumerary canine teeth, which are small, and situated behind the principal ones. The stomach is divided into two portions by a slight contraction in the middle; the intestines are furnished with remarkably long and numerous villi; the kidneys are conglomerated; the tentorium is bony; the nasal cartilages are extremely mobile.

Racoon.

(943.) In the racoon, another animal of this tribe, the valve of the colon is wanting, and the omentum is very large, consisting of innumerable lines of fat, disposed in a reticular form, and connected by an extremely delicate membrane having the appearance of a spider's web. The skin of the neck is very loosely connected by cellular substance with the subjacent muscles.

7. *Digitigrada.*

Digitigrada.

(944.) The cœcum is wanting in the greater number of the animals of this tribe. It is met with, however, in the ichneumon. Many have anal glands and follicles, which prepare a strongly odoriferous secretion. This is the case with the skunk, pole-cat, and several others. When these animals are pursued, they pour out this fetid matter, the odour of which is so offensive as to deter their pursuers from approaching them. The civet has also similar glands that secrete the peculiar perfume which derives its name from that animal.

Weasel.

(945.) The stomach, in the weasel tribe, is a simple cylindrical canal, having no expanded extremity to the left of the cardia; but the œsophagus enters at one end, and the intestine proceeds from the other, so that the food may pass quickly through it. In the stomach of the sea otter, Sir Edward Home describes a remarkable glandular structure near the pylorus. The receptaculum chyli, in this animal, sends two trunks to form the thoracic duct, which have frequent communications, so that there are sometimes three, frequently four, and never fewer than two branches of this duct, running parallel to one another. In two instances the foramen ovale of the heart was found open, but the ductus arteriosus was closed.

Dog.

(946.) In the dog a row of mucous glands, corresponding to the labiales and buccales in man, is found opposite to the molar teeth, having several small openings into the mouth. A large salivary gland also exists under the arch of the zygoma, covered by the masseter muscle. Its duct is nearly equal in size to that of the parotid, and opens at the posterior extremity of the alveolar margin of the upper jaw. What is called the *worm* in the dog's tongue, is merely a packet of tendinous fibres, passing longitudinally the whole length of its tongue, and lying loose in a membranous sheath, unconnected with any of the muscles. It has been supposed to assist in lapping up fluids in the peculiar way in which dogs are observed to drink. There is a popular, but wholly unfounded idea, that the extirpation of this pretended worm, is a preservation against hydrophobia. The anal glands are of considerable size.

(947.) The thoracic duct is double in the dog, and forms a large receptaculum chyli. The crista occipitalis varies considerably in its degree of prominence in the different breeds of dogs. In all, the tympanic bone is distinct from the temporal bone, being separated from it by a suture. The urethra passes along a groove in a cylindrical bone. In the hyæna, however, which in other respects is very similar to the dog, this bone is not found. The extremities of the rings of the trachea, in the hyæna, overlap one another, and admit of being much compressed; a circumstance which has been considered as connected with the shrill and peircing cry which this animal is capable of uttering.

Lion.

(948.) The genus felis, of which the lion affords the most remarkable example, resembles the dog in many circumstances of conformation. We find the same set of mucous glands about the mouth, and at the extremity of the rectum. The tongue is beset with sharp prickles, the points of which are directed backwards; they are of such strength as to tear off the skin from any part which the lion may lick. The stomach is divided by a slight middle contraction, into a cardiac and a pyloric portion. The ductus choledochus forms a pouch between the coats of the intestine for receiving the pancreatic duct. In all animals of this genus the tentorium is bony. The zygoma is arched, and very large and prominent. The long bristly hairs which constitute the whiskers, receive very considerable nervous filaments, and appear subservient to the sense of touch in a very remarkable degree. Two delicate membranes are met with lying under the ligaments of the glottis, and are probably the cause of the piercing sound peculiar to animals of this tribe. The retraction of the claws into a sheath is matter of familiar observation in the cat. The pupil of the lion is circular, but that of the cat has the form of a vertical slit when closed; and the motions of the iris appear to be partly voluntary.

8. *Amphibia.*

mphibia. eal.

(949.) Whiskers having the same properties are likewise found in the seal, an animal of aquatic habits, and whose conformation is modified with reference to the element it is intended to inhabit. The feet act as fins, adapted for swimming; the radius and ulna are flattened; the spine is very flexible; the pelvis very narrow. The bones have no medullary cavities. Neither the parotid nor the sublingual glands are met with in this or any other animal of the order of amphibia, belonging to the class mammalia; and the teeth are adapted chiefly to the seizing and detention of objects, and are scarcely capable of serving the purpose of mastication. The stomach is a straight cylinder, having no cardiac expansion. The intestinal canal is of great length, thus forming an exception to the general rule of its being comparatively short in carnivorous animals. The renal veins form a kind of net-work, the reticulations of which intersect the furrows between the mammary processes on the outer surface of the kidneys. The proportional size of the brain of the seal is greater than in most mammalia.

(950.) The eye of the Greenland seal is peculiarly formed, having, according to Blumenbach, the anterior segment of the sclerotica, or that immediately behind its junction with the cornea, thick and firm; its middle circle thin and flexible; and its posterior part very thick and almost cartilaginous, while the cornea itself is thin and yielding. The whole eye-ball is surrounded by very strong muscles capable of shortening the axis of the eye, and of adapting it, according to circumstances, to distinct vision in air; while in their ordinary state of relaxation, the axis of the eye being lengthened, the animal when under water is still enabled to see objects distinctly.

alrus.

(951.) The walrus, another animal of this order, is remarkable for the form of its teeth and tusks, part being external; but these fall more within the province of the naturalist. The zootomist may notice in this animal the smallness of the intermaxillary bone, and the total absence of the gall bladder.

9. *Marsupialia.*

arsu- alia.

(952.) The marsupial family of mammalia compose an interesting group of animals, which present many remarkable singularities in their internal conformation and economy. The principal of these is the apparently premature birth of their young, which come into the world at a period of their developement corresponding to that to which the fœtuses of mammalia have arrived only a few days after conception. Nearly the whole extent of the integument of the fore part of the abdomen forms a kind of sac or pouch for the reception of the fœtuses in their early state, and whilst they present only a shapeless mass, destitute of external members, and totally incapable of locomotion. They become attached to the nipples of the mammary glands, situated under the integument of the pouch next to the abdomen of the mother; and they remain in this situation for a long time, imbibing nourishment from these glands, until they acquire a growth equal to that which the young of other animals attain in the uterus before birth. Two bones, peculiar to these animals, and therefore called the marsupial bones, are expressly provided for the protection of the abdominal viscera, lying in the horizontal position of the trunk above this extraordinary pouch, which performs the function of a supplementary uterus. It is farther remarkable, that the same bones occur in the skeleton of the males, where, of course, there are no pouches; and also in those species where the fold forming the pouch is scarcely perceptible. The uterus communicates with the vagina, not by a single opening, but by two curved lateral tubes. This has been called the *uterus anfractuosus*, to distinguish it from the ordinary form, which is the *uterus simplex;* the *uterus bicornis*, which has two horns, either straight or convoluted; and the double uterus, or *uterus duplex*, which has the appearance of two horns opening laterally into the vagina, as in the mole, the hare, and the rabbit. The Fallopian tubes, in marsupial animals, are much enlarged at their extremities.

Opossum.

(953.) In the oppossum, the cardiac and the pyloric openings of the stomach are placed very near one another. The anal glands are large. The tongue is covered with pointed processes.

Kangaroo.

(954.) The kangaroo has a stomach composed of three pouches, but in consequence of the power which different portions of it possess of contracting separately, it is occasionally divided into a much greater number of portions.

Phascolome.

(955.) The phascolome, a species of rat from Australia, which possesses an abdominal pouch, is remarkable for possessing, in common only with man, and the orang-utan, both a cœcum and an appendix vermiformis.

10. *Rodentia.*

Rodentia.

(956.) In this order of mammalia, we find the incisor teeth furnished with enamel only in front; the frontal sinuses are absent; the os frontis is divided into two bones by a middle longitudinal suture, and the tympanic bone is distinct from the temporal. The brain presents no appearance of convolutions on its surface; the eyes are placed on the side of the head, so that the direction of their axes is completely lateral; and the orbits are not separated from the temporal fossæ; the cœcum, in particular, is exceedingly voluminous, so as often to exceed the stomach in size. The dormouse, indeed, presents an exception to this rule, being destitute of any cœcum.

Beaver.

(957.) The beaver has a remarkably strong and prominent zygoma. A peculiar glandular body is found near the upper orifice of the stomach, full of cavities, apparently for the purpose of secreting mucus. The urethra terminates in the rectum, thus constituting a kind of *cloaca;* a structure which, as we shall find, prevails universally in birds. The direction of the axes of the orbits is upwards.

Rat.

(958.) The common rat has no cœcum; its zygoma has its convexity turned downwards; the testes are capable of being retracted within the abdomen. A similar circumstance occurs in the hamster, the squirrel, and the guinea-pig.

Mus typhlus.

(959.) The mus typhlus is remarkable for having its eye covered over with the common integument of the face, which, together with the hair growing on it, completely intercept light, and must destroy the use of the eye as an organ of vision.

Hamster Marmot.

(960.) Cheek pouches are met with in many species of this genus; as in the case of the hamster and marmot. In the ear of the latter of these animals, a portion of bone is described by Cuvier as passing between the crura of the stapes, from one side of the fenestra ovalis to the other, the use of which conformation is entirely unknown.

Hare.

(961.) In the hare, the following peculiarities are met with. The coronoid process of the lower jaw is almost entirely wanting. The transverse processes of the lumbar vertebræ are remarkably large. The stomach may be distinguished into two portions, differing in the structure of their coats; the cardiac portion being lined with cuticle, and the pyloric division having the usual villous and secreting surface. The former may be regarded as a reservoir for the food, while the latter is the part which performs the function of digestion. The undigested state in which the contents of the stomach is found in the former, and its altered appearance in the latter, corroborate this view of the different offices of these two portions of the stomach. The rabbit agrees with the hare in this conformation. The cœcum is of enormous size; it extends to a length which is greater than that of the whole animal; it is curiously convoluted, and is lined internally with a peculiar spiral fold or valve. The urinary bladder is peculiarly large in the hare

(962.) The retina exhibits very distinct and beautiful medullary striæ, which pass, for the most part, in a transverse direction. The glandula Harderi is found in these animals, and unites itself with the proper lacrymal gland, but is distinguishable by its whiter colour. Both the hare and the rabbit have a slit, opening into the lacrymal canal, which serves as a substitute for the puncta lacrymalia. Sebaceous sinuses exist on the outer side of the upper jaw, near the nasal bones; whence a large quantity of a viscid adipose substance is secreted. Cavities are also formed in the groins, called by Pallas, *antra inguinalia*, which contain a strongly odorous substance prepared by the neighbouring subcutaneous glands.

11. *Tardigrada.*

Tardigrada.

(963.) The tardigrade mammalia are distinguished by having the same peculiar distribution of the arteries of the limbs which we have already noticed in the lemur tardigradus. They possess neither cœcum nor gall-bladder. The stomach of the sloth is complicated in its structure, being divided into several pouches; the intestinal canal is very short; there is also at its extremity an approach to the structure of the cloaca of birds, inasmuch as the rectum and urethra have a common termination. The zygoma is furnished with a large descending process, which comes from the os malæ.

Sloth.

(964.) The two-toed sloth *(bradypus didactylus)* has twenty-three ribs on each side. We have already noticed the apparent anomaly presented by the three-toed sloth, (the *bradypus tridactylus*) in its seeming to possess nine instead of seven cervical vertebræ; this appearance being given to the two last of these vertebræ, which are, in fact, dorsal, by the ribs which are attached to them being very short, and rudimental in their conformation, (see § 911.) In the anteater and manis, which belong to Cuvier's family of the edentata, the six last vertebræ of the neck are anchylosed or united so as to form only one bone.

12. *Monotremata.*

Monotremata.

(965.) The singular animals which compose this family of mammalia, instituted by M. Geoffroy, are all inhabitants of the continent of Australia, so fertile in extraordinary productions in every department of natural history. They are included in the genus ornithorhyncus, and are distinguished into the three species of paradoxus, histrix, and setosus.

Ornithorhyncus.

(966.) Although they are not furnished with abdominal pouches like the kangaroo and other marsupial animals, yet they are provided with two bones corresponding in their position to the marsupial bones, already described (§ 952), as attached to the bones of the pubis, and supporting the abdominal viscera. The number of ribs in the ornithorhyncus is seventeen. Pouches exist in the cheek of the animal. The bill, shaped like that of the duck, is abundantly furnished with nerves, chiefly from the second branch of the fifth pair. Its teeth have no fangs which sink into the jaw, as in most quadrupeds, but are merely imbedded in the gum, and are very peculiar in their shape. In the ornithorhyncus paradoxus, there is one on each side of either jaw; it consists of a horny substance of an oblong shape, flattened at the surface, and adhering to the gum. There are likewise two horny processes at the back of the tongue, which are directed forwards, and prevent the food from passing into the throat before it has been sufficiently masticated. The tongue is very short, not an inch long, and the moveable portion not half an inch; its surface is beset with long conical papillæ. The ornithorhyncus hystrix has six transverse rows of pointed horny processes at the back of the palate, and about twenty similar teeth on the corresponding part of the tongue. The intermaxillary bones are of a very singular shape, consisting of two hooked pieces joined together at their bases.

The stomach of the ornithorhyncus hystrix is lined with cuticle, furnished at the pyloric extremity with sharp horny papillæ. There is no valve of the colon, nor is there any cœcum, although we find an appendix vermiformis. They possess a cloaca at the termination of the rectum, as in birds.

(967.) Sir Everard Home denied the existence of mammæ in the female ornithorhyncus; but these glands have been distinctly delineated by Meckel, and described by him as being largely developed. In a paper since read to the Royal Society, Sir Everard Home again asserted that further inquiry had convinced him of the non-existence of these glands; but in a paper subsequently read to that learned body,[1] Mr. Griffin describes the mammæ of the ornithorhyncus paradoxus as considerable glands, which occupy the greater part of the under surface of the animal, and have numerous excretory ducts perforating the skin in two circumscribed places, but not forming any elevations analogous to nipples. This subject has, since that period, been investigated with great care by Mr. Owen,[2] who found the structure to correspond very exactly with the account given by Meckel, and he is accordingly led to regard them as real mammæ. The falx, as well as the tentorium, contains a plate of bone. The external auditory passage is very long and tortuous, and there are only two ossicula in the internal ear. A singular kind of clavicle is found in the skeleton of these animals, common to both the fore extremities, and situated in front of the ordinary clavicles, bearing some analogy to the furcular bone of birds. The conformation of the ribs also exhibits an approach to that of birds. Each rib consists of two pieces of bone; a longer one joined to the spine, and a shorter connected with the sternum; the two being united by an intermediate cartilage.

13. *Pachydermata.*

Pachydermata. Elephant.

(968.) In this natural family of animals, which was established by Storr, in his *Prodromus Methodi Animalium*, the elephant first claims our notice. In addition to the thick integument common to all the animals of this tribe, we find that remarkable organ, the *proboscis*, which is a prolongation of the nose, formed of a double cylindrical tube, extremely flexible in all directions, endowed with exquisite sensibility, and terminating in an appendix very much resembling a finger, all the functions of which it is capable of performing. The motions of this admirable organ are executed by an infinite number of muscular fibres, collected into small bundles, which pass in a great variety of directions, and are continually interlaced with one another, so as to be adapted to the performance of every kind of movement. The enormous tusks which are given to the animal as formidable weapons of offence, are merely developements of incisor teeth, proceeding from the inter-maxillary bones in the upper jaw, and which on issuing from the mouth are incurvated upwards.

(969.) That part of the cranium which corresponds to the frontal sinuses is enormously enlarged; the two tables of the skull being separated to a considerable distance from one another, the intermediate space being occupied by a vast number of cells, which are full of air, and communicating with the throat by means of the Eustachian tube. Camper has very ably pointed out the advantages resulting from this structure, by the increase of surface it affords for the attachment of the great muscles of the lower jaw, neck, and proboscis, and for the augmentation of their mechanical power. The frontal and parietal bones become united at a very early period with all the other parts of the cranium, so as to form a bony cavity in which no trace of sutures can be discerned. The tympanic bone, however, is distinct from the temporal. The optic foramina commence from a single canal, which receives the two optic nerves. A rudiment only of the nasal bones is observable; and the same remark is also applicable to the ossa unguis, or lacrymal bones; neither can we trace the existence of any lacrymal gland, or lacrymal sac, or any passage for the tears into the nose. The foramen ovale in the base of the cranium is very large. Between the arched sides of the upper part of the cranium, a broad and deep depression is met with, having a small longitudinal crest in the bottom.

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[1] *December* 15, 1831.

[2] *Philosophical Transactions* for 1832, p. 517. See also his paper in the *Transactions* for 1834, p. 333.

(970.) Between the eye and the orifice of the external ear, a gland of large size is situated, occasionally secreting a brown fluid, which oozes out through an opening in the skin. There are twenty ribs on each side; and there appear to be only three lumbar vertebræ. The ligamentum nuchæ is of great size and strength, for it has to support the enormous weight of the head with its ponderous tusks and proboscis. The articulation of the thigh bone with the pelvis, is destitute of the ligamentum teres, which is found in almost all other quadrupeds. The toes are five in number, but they are almost concealed by the thickness of the skin of the foot in which they are encased. The condyles of the lower jaw are simply rounded eminences. The form and structure of the teeth are very peculiar, and afford distinctive characters of the different species of elephants, which belong more properly to natural history. In addition to the usual component parts of bones and of enamel, a third is superadded, called the *crusta petrosa,* which fills up the interstices left by the duplications of the enamel. The ivory which composes the tusks is exceedingly dense, and differs considerably in its structure from the ordinary bone of other teeth. It is distinguished by the curved lines which pass in different directions from the centre of the tusk, forming by their decussation, a regular arrangement of curvilinear lozenges. The tusk is constructed by the successive deposition of osseous matter from within, being secreted from the outer surface of the vascular pulp, which occupies the central part of the growing tusk. Hence, iron balls, fired at the animal, have been known to penetrate the latter soft portion, and to remain fixed in the interior of the tusk, till they were completely covered over, and imbedded in the successive depositions of ivory.

(971.) The stomach is simple in its structure; the intestines are voluminous, the cœcum of great size, and the colon large, long, and divided into cellular compartments. There is no gall-bladder. The ductus choledochus forms a pouch between the coats of the intestine, as it does in the cat, for the reception of the pancreatic duct.

Tapir. (972.) The snout of the tapir bears a slight resemblance to the proboscis of the elephant; being, although much shorter, extremely mobile, and provided with a very complex arrangement of muscles.

Rhinoceros. (973.) The rhinoceros is furnished with a rough and slightly elevated surface of the large nasal bones, consolidated into one bone, for the attachment of the horn which is supported upon it. Such, at least, is the structure in the one-horned rhinoceros; in the two-horned species it is the front horn to which this description applies; for the posterior horn rests on a similar process of the os frontis. Like the elephant, the rhinoceros has no gall-bladder.

Hog. (974.) In the hog we also meet with a considerable developement of the frontal sinuses. The molar glands are large, and their openings very conspicuous. There are two considerable membranous bags in the throat, situated above and in front of the ligaments of the glottis. Two small flat bones are found at the base of the heart, at the origin of the aorta from the left ventricle. Their use has been supposed to be that of giving support to the valves of the aorta.

Peccari. (975.) The peccari, or Mexican musk-hog, has a remarkable gland situated in the back, near the sacrum; it is composed of several lobules, the ducts of which unite into one canal, which passes through the skin, and pours out a secretion having a scent similar to musk. A singular dilatation is often met with in the aorta of this animal, as if it were affected with aneurism.

14. *Solipeda.*

Solipeda. (976.) This family comprehends the horse, ass, zebra, and quagga. The great interest attached to all that relates to the horse, from its utility to man, has occasioned its anatomy, the study of which is the foundation of the veterinary art, to be cultivated with peculiar zeal. The principal circumstances worthy of notice in the osteology of this animal are the following. As is the case with most quadrupeds whose necks are very long, the cervical vertebræ have very short spinous processes. The dorsal vertebræ, the number of which of course corresponds with that of the ribs, being eighteen, and sometimes nineteen, have, on the contrary, very large and broad spinous processes. The space from the first to the eighth vertebra, is called the *withers,* against which the upper part of the shoulder rests. There are six lumbar vertebræ, having strong spinous, and also broad and long transverse processes. Large lateral processes also extend from the sacrum, which is composed of five consolidated portions; and the united spinous processes of these are likewise exceedingly prominent. The tail is formed of eighteen cylindrical pieces, which, towards the extremity, have nearly the softness of cartilage.

(977.) The true ribs are, on each side, eight in number, the remaining ten or eleven being joined to the sternum by cartilage. The sternum is composed originally of seven pieces of bone united into one. Its anterior extremity is sharp-pointed, like the prow or keel of a ship. In the pelvis of the horse, denominated the *haunch,* we find the ilium, or hip-bone, extended in three directions, above, below, and behind, forming three large processes, for the attachment of the strong muscles which surround the hip joint. The ischium is much extended, forming a strong process posteriorly for a similar purpose. This elongation of the ischium has been termed, from its figure, the *processus triquetrus ischii.* By removing the point of attachment of the muscles to a greater distance from the axis of motion, it gives them the mechanical advantage of acting by a long lever. The symphysis of the pubis (or the junction of the bones of that name) is remarkable for its depth, thus affording an extensive surface for the attachment of muscles.

(978.) The bones of the extremities of the horse are constructed on the same general model as the human, though varying much in the details of their form and relative proportions; and some parts only appearing in an imperfect or rudimental state. The scapula is of an oblong triangular shape, considerably narrower and longer than the same bone in the human skeleton, and exhibiting only faint traces of the acromion and coracoid processes. Its axis is nearly in the same line with the os humeri, which latter bone is very short, and scarcely descends below the line of the chest, and possesses scarcely any rotatory motion on the scapula. The radius and ulna are consolidated together; the olecranon is much elongated. The carpus, or as it is vulgarly called, the knee, of the horse, is composed of seven, or sometimes eight, small bones, disposed as in the human carpus, in two rows; though with respect to their individual form, they have but little resemblance to the latter.

(979.) That part of the skeleton which corresponds to the metacarpus is, in the horse, consolidated into a single bone termed the *shank*, or *canon bone*, to which are united behind, and on the side, two much shorter and very slender bones, called the *styloid*, or *splint bones*, frequently found consolidated with the canon bone by ossific union. It is only the latter, or principal bone, that is articulated with the next, or *pastern bone*, which corresponds with the first phalanges of the fingers, and may be regarded as the consolidation of these five bones into one. In like manner, the second phalanges are consolidated in the horse into the next bone of the foot, which is termed the *coronet bone*, and which is articulated by a divided condyle with the *coffin bone*, of which we shall presently speak. Before proceeding, however, we must notice two or three small rounded bones placed at the back of the pastern joint, (between that and the shank bone) which correspond in their office to sesamoid bones, and which have accordingly received that appellation.

(980.) The coffin bone corresponds in situation to the third phalanx of the fingers. It supports the single hoof; from which this family of mammalia derive their characteristic name. Connected with this is a small bone, called the *shuttle bone*.

(981.) In the posterior extremity we find a very similar arrangement of bones. The thigh bone is unusually short, scarcely extending beyond the trunk of the body, when surrounded by its muscles. The glutæi muscles, and especially the glutæus medius, are particularly powerful in their action for extending the thigh backwards, and performing the motion necessary for kicking. There is a process in this bone of the horse which is not observed at all in the human os femoris; it is a strong curved spine, situated on the outside, opposite to the lesser trochanter. It has been termed the *processus recurvatus femoris*.

(982.) The *patella* of the horse is large, thick, and very prominent. From the *tibia* there arises a small spinous process, which may be considered as the rudiment of a fibula. The tarsus, or *hock*, is composed of six or seven bones, and forms a very obtuse angle with the tibia, when the horse has his foot to the ground. The astragalus differs from the human bone of that name, by having two very large and prominent condyles. The metatarsal bones correspond in every respect with those of the carpus already described.

(983.) In the skull of the horse we may observe that the temporal bone is divided by a suture into the squamous and tympanic portions. The occipital bone has a deep depression in the middle, where the cervical ligament is attached. The antrum maxillare and turbinated bones are of great size. The lower jaw-bone is also very large, and presents a very extended surface for the attachment of muscles.

The horse is provided with a large salivary apparatus of glands. Its stomach is divided into two portions; the first of which, next to the œsophagus, is lined with a cuticular membrane which terminates in a loose expansion, supposed to have the office of a valve, and to prevent the possibility of the animal's vomiting. There are generally found adhering to its coats a great number of the larvæ of the œstrus equi, and the œstrus hæmorrhoidalis, called in common language, *botts*. The intestinal canal is of great length, the large intestine alone being twenty-four feet in length. The colon is very capacious, and divided into cellular compartments. The liver is large, divided by deep indentations into lobes, and unprovided with a gall-bladder.

(984.) The peculiar sound produced in neighing is ascribed to the presence in the trachea of a delicate membrane, attached by its middle to the thyroid cartilage, and of which the two extremities pass along the external margins of the rima glottidis. The Eustachian tube opens, not immediately over the larynx, but into a sac peculiar to this tribe of animals, situated on the lateral parts of the lower jaw; and these cavities then open by a long fissure, furnished with a cartilaginous valve, into the pharynx.

(985.) The eye of the horse presents a remarkably beautiful and delicate structure in the folds of the internal membrane of the corpus ciliare. The pupil is oblong, the superior margin of the iris having a fringed appearance.

15. *Ruminantia.*

Ruminantia.

(986.) The anatomy of the ruminant family of quadrupeds, which comprises so many of those animals that man has domesticated and rendered subservient to his most urgent wants, has also very strong claims on our attention.

(987.) In their skeleton they correspond very closely with the horse, of which we have already given so detailed a description. The principal differences are observable in the terminal bones of the extremities, each limb presenting us with two hoofs, instead of one, and a corresponding division of the metatarsal bones and phalanges into two. On the other hand, the slender traces of a fibula met with in the horse, disappear in the ox and other animals of this tribe.

Digestive organs.

(988.) The whole track of the alimentary canal in these animals presents us with objects of interest. The tongue is covered with a thick cuticle, provided with pointed papillæ, which, being directed backwards, are fitted for laying firm hold of the grass, and tearing it up from the roots. The salivary glands are extremely large; the coats of the œsophagus particularly strong and muscular, in subservience to the function of rumination peculiar to this tribe. The organs provided for digestion are more complicated than in any of the animals we have yet considered. There are no less than four cavities which have been regarded as performing the office of stomachs. The first is the *paunch*, which is a capacious reservoir, abundantly supplied with secretion from its coats, which are beset with numerous flattened papillæ. The second is the *honey-comb* stomach, so named from the reticulated appearance of its inner membrane, the folds of which are disposed in polygonal lines, somewhat resembling the hexagonal margins of the cells of the honey-comb. The third stomach, which is the smallest, is termed the *manyplies*, and contains a great number of broad folds, or duplicatures of its inner membrane, which have been compared to the leaves of a book. The fourth, or the *reed*, has a pyriform shape, an internal villous coat, and a structure altogether analogous to that of the simple stomachs of carnivorous animals. It terminates in the beginning of the intestinal canal. A groove extends from the termination of the œsophagus along the edge of the three first stomachs, at the part where they communicate together; the edges of this groove are thick, so as to admit, when brought into close contact, of forming a canal for the direct communication of the œsophagus with any one of these four stomachs.

Process of rumination.

(989.) The grass which the animal takes into the mouth undergoes but a small degree of mastication, and passes, on being swallowed, into the paunch, where it undergoes maceration, and is transferred, by small portions at a time, into the honey-comb, or second stomach, which serves to perform an auxiliary office to the first. Thence it is sent up again directly through the œsophagus into the mouth, for the purpose of undergoing a second and more deliberate mastication, which the animal performs when reposing, and from which it appears to enjoy considerable pleasure. After being thus ruminated it is again swallowed, and the sides of the groove being brought into contact, so as to constitute a canal, and exclude all passage into the first or second stomachs, it passes directly into the third stomach; whence, after having been subjected to the further action of the secretions of that organ, it is transferred to the fourth or last stomach, where the process of digestion is completed. Liquids drunk by the animal pass at once into the second stomach, and assist in the maceration of its contents. But the milk taken by the calf, requiring to be neither macerated nor ruminated, is conveyed directly from the œsophagus into the fourth stomach.

(990.) The biliary organs present us, in horned cattle, with numerous hepato-cystic ducts, conveying the bile immediately from the liver to the gall-bladder, which cyst is found in all the animals of this order, though it is absent in the horse. The urinary bladder is particularly large. In like manner, as we found in the pig, two small bones are met with also in ruminants, at the origin of the aorta; and the same purpose has been assigned to them as in the former instance. In the stag, these have been called the *bones of the heart.*

(991.) The internal carotid artery, at its entrance into the cranium, is suddenly subdivided into numerous branches, which are variously contorted, and afterwards re-united at the basis of the brain. The intention of this curious structure, which has been termed the *rete mirabile,* appears to be to diminish the impetus with which the blood would otherwise be forced into the arteries distributed to the brain; a force which would be increased by the effect of gravity when the animal stooped in grazing. The frontal sinus, and other parts connected with the sense of smell, are much developed. The lacrymal bones and ossa nasi are of considerable size. The tapetum is particularly conspicuous in the eyes of ruminants. One or two additional small bones are found among the ossicula auditus. The mastoid cells are numerous, and in the arrangement of their compartments somewhat resemble a ripe poppy head. In the ox and the sheep, the superior ligament of the glottis, as well as the ventricles of the larynx, are absent.

Camel.

(992.) Ruminant animals are distinguished into two tribes, the first consisting of those which are without horns; the second, of those provided with horns. Of the former, the camel is remarkable for the great expansion of the hoof, which adapts it for treading upon sand. It has seven lumbar vertebræ. A peculiar moveable bag, glandular in its structure, exists behind the palate, probably designed for the lubrication of the throat: it has received the name of *bursa faucium.* Connected with the paunch is a large receptacle divided into numerous cells, for the purpose of holding water, as in a natural reservoir. Hence, when a camel dies in the desert, the Arabs open the stomach, and quench their thirst with the water it contains, which is found to be pure and wholesome. Like the horse, it has no gall-bladder. It has no fibula; but this latter bone is met with in the musk, which is also a hornless ruminant.

Horns.

(993.) The horned ruminants have an eminence on the os frontis for supporting the horn. This process is in the stag a real bone, remarkable for the rapidity of its growth, which is annual, and for its death and separation from the skull at certain periodic intervals. The osseous bases of the horns of the ox, the sheep, the goat, and the antelope, on the contrary, are permanent, and are invested with a horny covering, which has a structure very different from bone. The cameleopard, or giraffe, on the other hand, has two osseous prominences, which remain permanently covered with the integuments, and are even surmounted by a tuft of hair. But the details relating to organs so external as the horns fall more properly within the province of natural history.

Cameleo-
ard.

Rein deer.

(994.) The rein deer has, like several of the baboon tribe, large laryngeal sacs on the front of the neck, communicating with the larynx.

Ox and
heep.

(995.) In the ox and sheep the spleen is remarkable for being of a distinctly cellular structure. In these animals we find a great developement of the salivary glands, and more particularly of the submaxillary gland, which extends along the side of the larynx quite to the back of the pharynx.

16. *Cetacea.*

etacea.

(996.) From the consideration of the quadrupeds of the class mammalia, we pass now to that of a tribe of animals which, although warm-blooded and mammiferous, are formed on a model adapting them for inhabiting the water; nature having bereft them even of the rudiments of hinder extremities. The bones of the spine are continued, without being interrupted by an interposed pelvis, into the vertebræ of the tail, which terminates in a horizontal fin. The head and trunk are united by a neck, so short as to exhibit scarcely any diminution of diameter, and containing cervical vertebræ, which are extremely compressed, and the greater number of which are consolidated together by a bony union. The superior extremities are supported by bones, which have no medullary cavities, and which, compared with the analogous bones of quadrupeds, are much shortened and compressed. They do not admit of motion amongst themselves, and being enveloped by a tendinous membrane, are reduced to the office of fins. The internal organs correspond, however, with that of other mammalia. Cetacea breathe by means of lungs, their circulation is double, and they are warm-blooded. The females are viviparous, and are provided with mammæ for the nourishment of their young.

(997.) The necessity of occasionally receiving air into the lungs, whilst the animal is generally immersed in water, renders it requisite that a provision should be made for their readily rising to the surface in order to breathe. Hence the movements of the tail are from above downwards; hence in the cachalot and other kinds of whale, a large quantity of oil is accumulated round the head, which gives greater buoyancy to this part of the body. Hence, also, when the animal, in seizing its prey, takes into the mouth a large quantity of water, there is a necessity of getting rid of it, which is effected by its transmission into a sac placed at the external orifice of the nasal cavity, whence it is expelled with great force, by the contraction of powerful muscles, through a passage which conducts it to the top of the head. In this way are produced the enormous spouts of water that mark the track of the whale on the surface of the sea.

(998.) The olfactory organs are not adapted to the possession of any accurate sense of smell, being furnished neither with turbinated bones nor with any considerable nerves. The larynx rises in a pyramidal form into the posterior part of the nostrils, in order to receive the air from those passages, and convey it to the lungs, without its being necessary for the animal to extend more than the end of the snout above the surface of the water. The glottis is simple, and is not interrupted by any projecting membranes.

(999.) The stomach is composed of as many as five, or sometimes even of seven distinct pouches. There is no cœcum or appendix vermiformis; and the gall-bladder is absent in the greater number. The spleen is divided into a number of small globular lobes. The kidneys are conglomerate. The brain is large, and its hemispheres much developed. The tympanic bone is separated from the rest of the cranium, adhering to it only by ligamentous connexions. There is no external ear; the stapes is nearly solid; in the walrus it exhibits no perforation. The ossicula, semicircular canals, and other parts of the labyrinth of the internal ear are remarkably small. The external meatus is cartilaginous, and so small, that its external orifice in the dolphin will only just admit a pin. It pursues a winding course through the fat, which is of great thickness, until it reaches the tympanum. The Eustachian tube opens at the blowing hole, and is furnished with a valve preventing the admission of the water which the animal expels through that passage. The lacrymal organs are entirely wanting; the sclerotic coat of the eye is very thick at its posterior part, so that although the eye-ball has exteriorly a spherical form, the figure of the vitreous humor is very different; its structure at the back of the eye has the hardness of cartilage.

(1000.) In many parts of the arterial system of the cetacea, we find reticular plexuses, or convolutions of the vessels, the purpose of which is probably to serve as reservoirs of arterial blood, for the use of the system, when the animal is long under water.

(1001.) In the trichecus manatus borealis, or manati, a gland of the size of the human head is found between the coats of the stomach, near the œsophagus, discharging, on pressure, a fluid resembling the pancreatic juice.

Whale.

(1002.) The whale is remarkable for having, in place of teeth, an apparatus apparently intended for filtration, and consisting of plates of the substance called *whalebone*, descending vertically into the mouth from the lower surface of the upper jaw, into which they are fixed by a ligamentous substance. On each side their number amounts to three or four hundred. The inner edge of each plate has its fibres detached so as to form a kind of fringe, which retains the small fishes and mollusca on which the animal feeds. The lower jaw is unprovided with any similar appendages. Although there are no teeth in the upper jaw, yet an intermaxillary bone is still present. Rudiments of teeth exist in the interior of the lower jaw before birth, lodged in deep sockets, and forming a row on each side. The developement of these imperfect teeth, however, proceeds no farther, and they disappear at an early period. The tongue, which is supported by an os hyoides of singular shape, is very thick and fleshy. The œsophagus is exceedingly narrow. The stomach is complicated in its structure. The intestinal canal is of considerable length, and contains a great number of longitudinal folds. There is a short cœcum. The mesenteric glands contain large spherical cavities, into which the trunks of the lacteals open, and where the chyle is probably blended with secretions proper to those cavities. The eye is extremely small in comparison with the size of the animal; and it occupies but a small portion of the orbit.

SECT. II.—*Comparative Physiology of Birds.*

1. *General Description.*

Birds.

(1003.) The whole of this class of animals exhibits great uniformity in its comparative anatomy; insomuch that the whole may easily be comprised in one general description. The structure of every part of the frame of birds is adapted to facilitate rapid progression through the air; for which purpose the anterior extremities are converted into wings, and are not employed in any other action. The support of the body when the animal is not flying, is entrusted solely to the posterior extremities; so that birds are, strictly speaking, *bipeds*. Hence we may trace some degree of approximation to the human structure in the conformation of the skeleton.

Skeleton.

(1004.) The bones are dense in their texture, but are at the same time rendered light by having large cavities, occupied, not with marrow, as in the mammalia, but with air. There is a smaller proportion of cartilaginous to osseous structure in the skeleton of birds than in that of quadrupeds.

(1005.) The neck of birds being required to be very flexible, we find the cervical vertebræ very numerous, and freely moveable upon one another. The swan has twenty-three cervical vertebræ. Those of the back, on the other hand, are perfectly fixed and immoveable, their spinous processes being large and often united by osseous substance, so as to preclude the possibility of any relative motion. As the ribs occupy the whole of the sides of the trunk, there are properly no lumbar vertebræ. The os coccygis is short and compressed; and can scarcely be regarded as a proper tail, although it affords support to the long feathers which constitute what is usually called the tail of birds. The pelvis consists almost entirely of a broad os innominatum, the lateral portions of which are widely separated, in order to admit of space for the developement of the eggs; and for the same reason the two ossa pubis do not join to form a symphysis, but are at a considerable distance from one another. The exceptions to this general rule will be noticed afterwards.

(1005.) The number of true ribs never exceeds ten pair; the false ribs are numerous, and directed forwards. Those which occupy the middle of the body are distinguished by a flat process, directed upwards and backwards. The sternum is composed of five pieces, and is of great size and strength. From the middle of its lower surface there rises a sharp process, or spine, resembling the keel of a ship, and evidently adapted to accommodate the large and powerful pectoral muscles, which take their rise from this part of the chest, and which act in depressing the wings. The bones which connect the wings to the trunk are apparently three in number; the coracoid process of each scapula being distinct and largely developed bones, having the semblance of ordinary clavicles, whilst the real clavicles are consolidated into a single bone, denominated the *furcular bone*, from its resemblance to a fork, and which in the fowl is better known by the name of the *merry-thought*. Its extremities rest on two strong processes of the scapula. Many anatomists, considering the coracoid as the true clavicles, have regarded the furcular bone as an additional, or supplementary clavicle, corresponding to the coracoid apophysis.

(1006.) The bones of the wing are analogous in their divisions and distribution to those of the upper extremity in man: there being a humerus, radius, and ulna; two carpal bones; and two metacarpal bones, generally consolidated into one; one bone corresponding to that of the thumb and two fingers; that next to the thumb consisting of two phalanges, and the outer one, of a single bone.

(1007.) In the legs we find a femur and a tibia, to which there adheres a very slender fibula, (which is, indeed, often wanting;) one metatarsal bone, and the phalanges of the toes. The patella is often supplied by a process from the tibia.

Provision for roosting.

(1008.) The muscles possess a high degree of irritability, and contract with great quickness and force. Many of the tendons become ossified in the progress of age. A remarkable arrangement exists in the tendons of the flexor muscles of the toes, by which the flexion of the knee and heel puts them on the stretch, and thus mechanically bending the toes, enables the bird to lay firm hold of the branch of a tree or perch whilst roosting. This is effected by the flexor tendons passing round over the outer side of the angle formed by each of these joints. Thus a bird, while roosting, supports itself on one leg only, by the mere effect of the weight of the body producing the necessary flexion of the toes, to enable it to preserve its hold. This remarkable provision of nature was long ago observed, and well explained by Borelli; and though the fact has been controverted by Vicq. D'Azyr, it appears to be well established. In order to give great latitude of motion to the head, the articulation of the os occipitis with the atlas is performed by a single condyle only, which procures it the advantages of a ball and socket joint. This condyle is situated at the anterior margin of the great occipital foramen. The proper bones of the cranium are not joined by sutures, but are consolidated into a single piece. The orbits for the eyes are very large, and are frequently found to communicate laterally in the skeleton, being separated, in the living animal, only by a thin membranous partition. The ossa unguis are generally very large. The upper jaw is almost always moveable upon the other bones of the head. To this bone is joined the bill, the structure of which is horny, and thus supplies the place of teeth, occupying the situation of the palate. The functions of the teeth, indeed, are not wanted, for the animal swallows its food without any mastication. The lower jaw is connected with the skull by the intermedium of a peculiar bone of irregular form, called the *os quadratum*. Another small bone resting against the palate is connected with it.

Digestive rgans.

(1009.) The energy of the digestive functions in birds corresponds with that of respiration, and muscular irritability. The stomach may be considered as consisting of three cavities; the first of which, termed the *crop*, is rather a dilatation of the œsophagus, furnished with numerous glands disposed in a regular arrangement of rows; the second is the *ventriculus succenturiatus*, or *pro-ventriculus*, situated lower down, and just at the entrance of the proper stomach. It is furnished with a still more complex glandular apparatus; and hence has been termed the *bulbus glandulosus*. Its form and structure vary much in different genera of birds. The third is the proper stomach, which resembles in the structure of its coats the simple stomachs of the mammalia, being thin and membranous in those birds which feed on insects and flesh. But in all granivorous birds the coats of this stomach are farther armed with a thick cuticular lining, of nearly the density of horn, which is surrounded by four immensely thick and powerful muscles, capable of exerting a strong compression on the contents of the stomach, and a slight degree of lateral motion, and thus performing the office of trituration. Such is the structure of what is called a *gizzard*. Between these opposite structures there exists, in different species of birds, a great number of intermediate gradations, corresponding to the peculiar nature of the food to which nature has adapted their organization. The trituration of the grain is assisted by small stones voluntarily swallowed by the animal, and in the selection of which the animal is directed by a principle of instinct.

(1010.) The intestinal canal of birds is much shorter than in most of the mammalia; but a similar disparity is also noticed in the former, with regard to the greater length of the canal in birds consuming vegetable food, when compared with that of the carnivorous tribes. There is scarcely any distinction in point of size between the small and large intestines; though the division between them is generally marked by the presence of two cœca. The rectum terminates in an expansion, termed the *cloaca*, in which the ureter terminates, and which therefore performs the function of the urinary bladder. Connected with the cloaca, there is an oval glandular bag termed the *bursa fabricii*, and opening into it by a narrow longitudinal aperture. The oviduct in the female also opens into the same cavity. Two blind pouches. opening into the rectum, are found near to its termination.

(1011.) The liver of birds is usually divided into two lobes; but in some birds there is in addition a third smaller lobe. Two ducts proceed from the liver; the one is the hepato-cystic duct, the other the hepatic duct. The former conveys the bile into the gall bladder, the latter into the duodenum. Thus the bile is conducted into the duodenum by one hepatic duct distinct from the cystic duct, and these two alternately with two or three ducts from the pancreas, which is large, and generally consists of two distinct glands; the spleen, on the other hand, is usually round, and of small size. The gall-bladder is situated under the right lobe of the liver; but some birds have no gall-bladder. There is no omentum. The chyle is transparent; there are no glands in the mesentery; the thoracic duct is double. Magendie has denied the existence of lymphatic vessels in birds; but they have been distinctly seen by others. ' The kidneys form a double row of conglobate glands, connected together, and situated on the sides of the lumbar vertebræ, in the hollows of the ossa innominata. There is no cavity corresponding to the pelvis of the kidneys of the mammalia; but renal capsules, similar to those of mammalia, are found also in birds.

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(1012.) The heart of birds is furnished, as in the mammalia, with a double set of cavities; the one subservient to the general or systemic, and the other to the pulmonary circulation. The valves of the right ventricle are supplied by a strong triangular muscle, which gives additional impetus to the blood propelled into the pulmonary artery. Jacobson has discovered a singular distribution in the abdominal veins; those returning the blood from the hinder extremities being ramified through the kidneys and liver, previously to their termination in the vena cava.

Lungs.

(1013.) The lungs are not divided into lobes, and are fixed in their situation, being tightly braced in the cavity formed by the ribs, on each side, by a membrane, which is perforated by a number of holes. These apertures are the terminations of collateral branches of the bronchiæ, through which the air received into the chest passes out, and circulates through a multitude of cells interspersed through various parts of the body, and communicating ultimately with the central cavities of the bones. An immense surface is thus exposed to the influence of the air, which, having access to every part of the body, acts very extensively on the blood circulating in the vessels lining these air-cells and cavities. Hence the energy of the function of respiration is greater, and the temperature higher, than in any of the mammalia. There is properly no diaphragm in birds; a few muscular fibres only surround the larger air-cells, and assist in expelling the air from them back again into the lungs. The trachea is supported by a series of cartilages, which form entire rings, and overlap each other at their upper and lower margins, so as to preserve the tube open amidst the violent bendings and twistings of the neck. It is provided, at its bifurcation, with a peculiar set of muscles, which, aided by a second rima glottidis, enable this part to perform the functions of a second larynx, and to give rise to sounds; and, indeed, to be apparently the principal organ of the voice. In many aquatic birds, as in the male swan, the trachea makes a large circumvolution, which is contained in the hollow of the sternum. In other birds it is not enclosed in this bone; but there is a bony structure surrounding the inferior larynx, which tends to strengthen the voice. These convolutions and bony cells of the trachea, have been compared in their office to the turns of the French-horn, or the divisions of a basoon. This great developement of the vocal organs is peculiar to the male bird.

Brain.

(1014.) The brain of birds is characterized by the smallness of the hemispheres, which are not united by any corpus callosum. There is no appearance of convolutions on its surface. The optic thalami are voluminous, and are situated behind and below the hemispheres; a cavity is found in each. The crura of the cerebellum do not form any eminence at their junction with the medulla oblongata, corresponding to the pons varolii. The cerebellum is comparatively large, but has no lateral lobes, being almost wholly constituted by the processus vermiformis. The total bulk of the brain, compared with the size or weight of the body, is generally greater than in the mammalia.

Eyes.

(1015.) The eyes of birds are very large, in proportion to the size of the head, and appear to be adapted to a great range of vision. The adjustment of the position of the lens appears to be effected by means of a vascular and plicated membrane, called the *marsupium*, extending obliquely from the bottom of the retina, through the vitreous humor, to the edge of the crystalline. Its figure is trapezoidal; its surface is covered with the pigmentum nigrum, which of course absorbs all the rays of light that fall upon it. The anterior part of the eye-ball is, in many carnivorous birds, strengthened by a circle of bony plates, lying close upon the sclerotica, and overlapping each other. Besides the two external eye-lids, birds are always provided with a strong nictitating membrane, proceeding from the internal corner of the eye, and drawn over the cornea by a special muscular apparatus. In some birds the lower eye-lid is the most moveable, and in others it is the upper.

Ear.

(1016.) There is no cartilaginous external ear; what has this appearance in the owl is formed only by the feathers;

the cavity of the tympanum contains only one ossiculum auditus, and communicates with the air-cells of the skull. The Eustachian tubes have a common opening over the arch of the palate. The part corresponding to the cochlea has the figure of a cone, with scarcely any curvature, but with two scalæ. The semicircular canals are large, and project from the bone.

Nostrils. (1017.) The nasal organs are unprovided with an æthmoid bone; the olfactory nerves passing to them through the orbits, and being distributed upon the *bullæ turbinatæ*, which are oftener cartilaginous than osseous in their structure.

Tongue. (1018.) The tongue is thick and fleshy, covered with a thick cuticle, and therefore not adapted to be an organ of taste. It is supported by an os hyoides of a singular shape, having besides the anterior and posterior processes, and the cornua, with their appendices, another bone jointed to it anteriorly, and moveable on it. This last bone, which supports the tongue, is called *the lingual bone*.

Incubation. (1019.) The evolution of the chick from the egg being a subject of great interest, has long engaged the attention of physiologists. The following is an outline of the history of these changes in the common fowl. The ovulum, or first rudiment of the egg, is formed in the ovary, and consists simply of a bag containing the yolk; this afterwards becomes covered in its progress along the oviduct, by successive layers of albuminous substance, which composes the white of the egg, so called from the colour it assumes when coagulated. The white of the egg is invested with a firm membrane, which is easily divisible into two layers; and there are also other membranes dividing the mass of albumen into concentric layers. The membrane of the yolk, the *membrana vitelli*, or *yolk-bag*, is connected with that of the white, or the *membrana albuminis*, by a kind of ligament, which extends from the two ends or sides of the yolk, to those of the white; these, when partially stretched and torn by the motion of the yolk, have a flocculent appearance, and form what are called the *chalazæ*. They appear to act as ligaments to the yolk, keeping that surface uppermost in which the chick is situated, so that it may receive warmth from the hen during incubation. In the lower part of the oviduct the egg acquires a calcareous covering or shell, which is secreted by the inner membrane of that canal, and which is composed of nine-tenths carbonate of lime, the remaining portion being phosphate of lime and animal matter. Between the two membranes which line the shell, a small quantity of air is contained at the larger end of the egg.

(1020.) A small, round, milk-white spot, called the *cicatricula*, is formed on the surface of the yolk-bag during incubation. It is surrounded by two or three concentric circles, called the *halones*. Previously to the appearance of the embryo, a small shining spot of an elongated form, with rounded ends, but contracted in the middle, is seen within the cicatricula. This is called the *areola pellucida*. In the centre of this may be discerned, on the second day, a gelatinous filament, bent into a curve. This is the *primitive trace*, or earliest perceptible rudiment of the chick, in which the first organs that can be discovered are the two lobes of the brain, and the primitive filaments of the spinal cord, with the caudal dilatation. Vessels begin to appear on the surface of the yolk-bag, being spread on a separate membrane, and presenting what has been called the *figura venosa*, or *area vasculosa*, the marginal vessel at the remotest part being termed the *vena terminalis*. These veins correspond to the mesenteric veins; they are collected together, and form the vena portæ, whilst the arteries are derived from the mesenteric artery of the chick. The heart may next be perceived, as three red pulsating points, constituting the *punctum saliens*. These points are the rudiments of the auricle, ventricle, and aorta. Next, the separate vertebræ may be distinguished, then the eyes, and afterwards the stomach, liver, and intestines. Then a vascular membrane, the *allantois*, is rapidly formed, having the form of a bladder communicating with the cloaca. It soon extends over nearly the whole of the internal membrane of the shell, and is covered with numerous ramifications of arterial and venous vessels, derived from the internal iliacs of the chick; the former contain carbonized blood, and are therefore dark coloured; the latter, which conduct back the same blood after it has received the influence of the air at the surface, have a bright scarlet hue, and unite in forming the umbilical vein of the chick. Hence it is evident that this membrane performs a function analogous to that of the placenta in mammalia, and to that of the future air-cells of the lungs, or, in other words, that it is the organ of embryonic respiration. The chick is nourished by the matter of the yolk, which is partly absorbed by yellow vessels (*vasa vitelli lutea)* having a fringed appearance, and flocculent extremities, floating in the yolk, and partly by the direct passage of this matter into the intestine by means of a canal of communication, called the *ductus vitello-intestinalis*. The white of the egg also gradually disappears, being absorbed into, and mixed with the yolk. Towards the latter periods of incubation, the whole of the yolk-bag is taken into the abdomen, and soon disappears. On the twenty-first day of incubation, the chick, being fully formed, breaks the shell which confines it, and enters into the world; for which temporary purpose it is provided with a hard beak, which is afterwards lost.

2. *Peculiarities in particular Families and Genera of Birds.*

(1021.) The shades of difference in the anatomy of each organ in individual genera and species of birds, are exceedingly numerous, and to enter into their detail would far exceed the limits within which we are obliged to confine ourselves in this treatise. We must not, however, pass over some of the most remarkable differences which offer themselves to our notice in a few families of birds. Amongst these none are more singular than those presented by the tribe of the brevipennes of Cuvier, comprehending the ostrich and the cassowary. These birds not being intended for flight, have very imperfectly formed wings; the sternum exhibits no carinated figure, but presents a plane and uniform surface, being destitute of an inferior spine; the pectoral muscles of the hinder extremity, on the contrary, are very large and powerful. The furcular bone exists only in a rudimental state. The pelvis of the ostrich differs from that of all other birds in being closed below by the complete junction of the ossa pubis. The cœca in this bird are furnished with a remarkable spiral valve. The feathers are also exceedingly peculiar; but as this subject belongs rather to the external characters, we cannot dwell upon it here.

Brevipennes.

Levirostres. (1022.) The same consideration prevents us from dilating on the varieties in the structure of the bill, and of the toes, which offer to the naturalist abundant topics of interesting inquiry. We shall only remark that the cellular bills, which are of such enormous size in the levirostres, have free communications with the air cells subservient to respiration, and may therefore be auxiliary to that function.

Woodpecker. (1023.) The tongue of the woodpecker is provided with a singular apparatus for darting it forwards with great rapidity; this is effected by a long cartilaginous band, which passes completely over the top of the cranium, and is fixed to a groove on the right side of the upper jaw.

Sect. III.—*Comparative Physiology of Reptiles.*

1. *Reptiles in General.*

Reptiles. (1024.) The class of reptiles comprehends all those vertebrated animals which breathe atmospheric air by means of lungs, but which are cold-blooded. This latter quality is a consequence of the partial extent of their respiration, the heart being so constructed as to transmit to the lungs only a portion of the circulating blood, and the remaining part being again sent into the arterial system of the body without having been exposed to the action of the air. Reptiles are distinguished by the negative characters of being destitute of either hair or feathers, and having no mammæ, organs for which there appears to be no occasion, in consequence of these animals being oviparous. The limited degree in which their blood is oxygenated appears to have a considerable influence on the whole condition of their vital functions. Not only is the temperature of the blood scarcely different from that of the surrounding medium,[1] the actions of life seem to be more sluggish and torpid, and the muscular powers less energetic; their sensations are more obtuse, and in cold climates they pass the winter in a state of torpor. The comparative smallness of the pulmonary system of vessels, and the less extent of the surfaces of the air-cells of the lungs, render them less dependent on respiration than warm-blooded animals; hence they bear submersion under water for a considerable time with impunity, although, if the interruption to respiration be too long continued, they ultimately perish, with as much certainty as any of the mammalia would do under similar circumstances.

There is ground for believing, according to Geoffroi St. Hilaire, that crocodiles and turtles possess, in addition to the ordinary pulmonary respiration, a partial aquatic abdominal respiration, effected by means of two channels of communication which have been found to exist between the cavity of the abdomen and the external surface of the body, and also that some analogy may be traced between this aquatic respiration in reptiles, by these *peritoneal canals*, and the supposed function of the swimming bladder of fishes, hereafter to be described, in subserviency to a species of aerial respiration.

(1025.) As their vital functions do not require for their performance any elevated temperature, so we find reptiles destitute of those appendages to the integuments, such as hair, wool, or feathers, which in the other classes retain the warmth of the body. Their brain is very small compared with the rest of the nervous system, being less necessary for the exercise of the vital actions. The parts immediately instrumental in sensation are less concentrated in a particular spot, but would appear to be more diffused over the spinal cord and ganglia. Thus they not only continue to live, but even exhibit motions which have the semblance of being voluntary, though probably not so in reality, long after the loss of the brain, or even of the entire head. In like manner the irritability of their muscles is retained for a much longer time, after they have been separated from the body, than in the case of warm-blooded animals. The heart, when removed from the body, still continues to beat for several hours; and the body, thus deprived of its heart, may still possess the power of voluntary motion, in consequence of the continuance of a species of obscure circulation, which is carried on in the capillary system of vessels.

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ptiles.

(1026.) Reptiles present a much greater variety of forms and of structures than is met with in any other class of vertebrata. The characters of the orders are derived principally from the form of their organs of progressive motion. These orders are four in number, namely, *chelonia*, *sauria*, *ophidia*, and *batrachia*.

2. *Chelonia.*

ielonia.

(1027.) This order comprehends turtles and tortoises, animals whose skeleton presents a trunk composed of two large plates of bone, the one derived from an expansion of the dorsal vertebræ and ribs, the other from a corresponding expansion of the sternum; these are united at the edges, and form a complete case for the thoracic and abdominal viscera, leaving apertures in front for the head and neck, together with the fore legs, and behind for the hind legs and tail. This arrangement produces a singular reversal of the positions of the scapula, the pelvis, and the muscles attached to these bones, all of which, instead of being placed externally, are situated in the interior of the ribs. The humerus is remarkably curved, especially in the tortoise, where it has nearly the form of a semicircle. The radius and ulna are distinct from each other; the carpus and phalanges are short and stunted, forming a compressed sort of hand. The vertebræ of the neck and tail are the only parts of the spinal column which are moveable upon one another.

(1028.) The cavity in which the brain is contained is very small compared with the size of the skull, the greater part of which consists of the bones surrounding the orbit, and giving attachment to the large muscles that move the jaw. There are no teeth, and the horny coverings of the jaws has some resemblance to a horse's hoof in the mode of its connexion with the bones. The tongue is short, and covered with villi, which extend also down the œsophagus; their points are all directed towards the stomach, so as to prevent the return of the food when it is once swallowed. The stomach is simple in its structure; the intestinal canal of moderate length; its inner membrane presenting only longitudinal folds, together with innumerable villi, which are more thickly set in the upper part of the canal than in the lower; there is no cœcum, but occasionally small processes, or appendices epiploicæ, are attached to the outer membrane. The urinary bladder is exceedingly capacious. The lungs are voluminous, and are contained in the same cavity as the abdominal viscera. The air-cells are very large, and the general texture of the lungs is loose. Respiration is performed entirely by the muscles of deglutition; the animal in fact closes its mouth, and swallows the air received from the nostrils, which is thus poured down into the trachea, the os hyoides being alternately raised and depressed. The liver is divided into two round irregularly-shaped masses.

(1029.) The heart has two auricles, separated by a complete septum, the one receiving the blood from the venæ cavæ, the other from the pulmonary veins. The ventricle into which these veins pour their contents is single, but has two chambers of unequal size, which communicate together, so that the blood received from the lungs is more or less mixed with that returning from the body in the systemic circulation; and it is this mixed blood which is sent through the aorta. The pulmonary artery is merely a branch of the aortic system.

(1030.) In the internal ear, we find a tympanum, Eustachian tube, and semicircular canals, together with ossicula, and also stony concretions in the vestibule. The eye has a bony ring at the anterior part of the sclerotica, as in birds. There are large lacrymal glands, and a very moveable membrana nictitans.

3. *Sauria.*

Sauria.

(1031.) The various animals included in this order, or the tribe of lizards, have a heart with two auricles, with generally four feet, and a scaly integument. They are always provided with teeth, and with nails; there is invariably a tail. The ribs are very moveable, and their motions are subservient to respiration. The lungs are long and vesicular, extending far into the abdominal cavity.

Crocodile.

(1032.) The crocodile may be taken as an example of this order. Its jaws are of immense size. The upper jaw consists of a large intermaxillary bone, which is immoveably joined with the skull, although the animal, in opening the mouth, appears to raise it independently, a circumstance which misled the older naturalists into the belief, that it was really moveable. There is an os quadratum as in birds. The sternum extends to the abdomen, and consists of seven pair of cartilaginous arches, to which ten ribs, not however reaching to the spine, are attached. There are no clavicles. The tongue is thick and flat, and attached very near its edges to the jaws, so as not to be easily perceived.

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[1] The temperature of animals of this class has been shewn by the experiments of Dr. Davy, Tiedemann, Czermack, and Wilford, to be in general two or three degrees higher than that of the surrounding medium. It partakes, however, of the vicissitudes in the temperature of that medium.

The teeth are of the simple conical kind chiefly adapted to the prehension and retention of the food; and each tooth when worn, is replaced by a fresh one, which grows underneath it; a succession which takes place several times during the life of the animal.

The œsophagus has the shape of a funnel, and leads to a stomach which resembles that of granivorous birds, in the thickness of its coats, and the approximation of its two apertures. The liver has two distinct lobes. There is no urinary bladder. The single ventricle of the heart is divided into three compartments, which communicate together; there is one cavity belonging to each auricle, and an intermediate cavity, into which the blood from the two others is poured, and where the intermixture of the carbonized and oxygenated portions is made. There is an external meatus of the ear, which may be voluntarily closed by a species of lips. Ossicula auditus are found, as well as stony concretions in the vestibule. In the other kinds of lizards, the tympanum is on a level with the integuments, and there is no external meatus. A membrana nictitans is found in the eye. The area of the section of the cavity containing the brain does not occupy the one-twentieth part of that of the whole head.

Chameleon. (1033.) The chameleon has comparatively a large head; but its brain is only of the size of a pea. Its lungs have numerous projecting processes. The tongue is constructed in a manner which bears some analogy to that of the woodpecker in the mechanism by which it is darted forwards to a considerable distance from the head, and suddenly retracted. It terminates in a sort of club, which is moistened with a glutinous secretion, for seizing flies and other insects, and its upper surface is hollowed. The eyes project considerably from the head, and admit of being turned very freely in their orbits. The most singular circumstance in the constitution of this animal, is the change of colour of its skin under various circumstances of temperature or excitement. These changes appear to be connected with the variable activity of respiration, which quickly influences the colour of the blood circulating under the very transparent skin; and which is visible to a greater depth, in consequence of the ample extension of the lungs along the sides of the abdomen: when the lungs are inflated, indeed, the whole body appears as if it were semi-transparent.

Draco volans. (1034.) The draco volans is a remarkable instance, in this tribe, of the subserviency of the ribs, which are expanded on each side so as to support a thin membrane resembling a wing, to the purposes of progressive motion.

4. *Ophidia.*

Ophidia. (1035.) Serpents, being wholly without feet, are constrained to crawl upon the surface of the earth, and are, therefore, more especially entitled to the appellation of *reptiles.*

(1036.) Their skeleton presents us with the simplest possible condition of the vertebral type; for it consists merely of a simple spinal column descending from the head, and furnished only with ribs. There appears, at first sight, to be no vestige either of sternum, of scapula, or of pelvis; the body of each vertebra is articulated by a convex surface, which is received into a concave surface of the next. The number of vertebræ is often exceedingly great; being sometimes as many as three hundred. The number of the ribs corresponds with that of the vertebræ, and when acted upon by their muscles, they assist in the progressive motion of the animal, by pressing on the ground, in succession, like imperfect feet. In the rattle-snake, the last vertebræ of the tail are broad and covered with the hollow pieces which compose the rattle. Obscure rudiments of pelvic bones were found by Mayer to exist in the anguis fragilis, the anguis ventralis, and the typhlops crocotatus; and it is probable that they may be discovered in most reptiles of this order. Some serpents have external claws, which may be considered as rudiments of feet. In others they exist concealed under the skin; and in others, again, there are cartilaginous filaments which Mayer regards as rudimental claws, connected with a series of small bones, which appear to be the rudiments of the bones of the lower extremities.

(1037.) The upper jaw-bone is detached from the rest of the skull, and admits of great latitude of motion. In most species of serpents, the jaws are so constructed as to render the mouth capable of great dilatation, and to enable it to receive objects even larger than the animal itself, and a corresponding power of dilatation exists also in the œsophagus.

(1038.) Serpents that are not venomous have usually four maxillary bones in the upper jaw, beset with small teeth, placed in two rows, widely separated from one another. The external row is not found in venomous serpents, but in their place large tubular fangs are met with, which are the terminations of the ducts from the poison bags, and which convey the venom into the wound inflicted by the tooth. This poison is secreted by glands, situated below the eyes, and surrounded by very strong muscles. Teeth.

(1039.) The stomach of serpents can scarcely be distinguished from the lower extremity of the œsophagus, and is very short, compared with the great length of that canal. There is no urinary bladder, the ureters opening at once into the cloaca.

(1040.) The heart has generally two auricles, though in some genera only one is met with; the ventricle is always single. The lungs consist of a membranous cavity, on the sides of which there are cells; their form is exceedingly elongated. The lung on one side is often much smaller than the other. The tongue is long and slender, and forked at the extremity; its root is contained in a kind of sheath, whence it can be protruded and retracted at pleasure. There is properly no tympanum belonging to the ear; but the long process of an ossiculum is found under the skin, and is connected with a tympanic bone.

5. *Batrachia.*

(1041.) The batrachia, (so termed from the Greek name of the frog, which may be assumed as a type of this order,) have a heart consisting of only a single auricle and ventricle; when arrived at maturity, they are possessed of two lungs; but in the earlier stages of their growth, they are wholly aquatic animals, and breathe like fishes by means of gills, which are affixed to the sides of the neck, by cartilaginous arches connected with the os hyoides. Such is the condition of the tadpole, which is the young of the frog. The aorta, on its exit from the heart, sends branches to each of the gills; whence the blood is collected by corresponding veins, that unite near the back to form a single arterial trunk, which again ramifies and distributes the blood to every part of the body, including the rudimental lungs, which are not yet developed In the process of the transformation of the tadpole into the frog, though these branchial arteries become obliterated, yet the vessels which supply the lungs remain, and are afterwards the channels of pulmonary respiration. Batrachia.

(1042.) In the skeleton of the frog, in place of ribs, small slender cartilages affixed to the extremities of the transverse processes of some of the vertebræ, which in the dorsal vertebræ are very broad. The spine is short, and terminates behind in a straight sacrum, which is impacted into the fork-shaped or innominatum. The scapula is thin and flat; and, together with the clavicles, are united to the sternum; but as there are no ribs, these, with the bones of the anterior extremities, are detached from the rest of the skeleton. There are properly no teeth; but the margin of the jaws is serrated. The urinary bladder exists, and is even sometimes double.

(1042.) The lungs do not collapse on opening the chest; this arises from the power which the frog possesses of distending them by the muscles of the mouth; the respiration being conducted on a plan similar to the one which has been already described in the tortoise, (§ 1027). Many species, as the pipa, have the vocal organs much developed. The tongue is of great length, and doubled back in the mouth; it is thrust forwards to a considerable distance in seizing its prey, and retracted with great rapidity. There is no external meatus to the ear; but the membrana tympani is external, and appears as part of the integument. The Eustachian tube opens at the fauces by an expanded mouth. There are two ossicula auditus; and the vestibulum contains rudiments of the calcareous bodies met with in other reptiles, and still more remarkably in fishes. The eye has two fleshy eye-lids, and also an internal nictitating membrane, which is transparent and horizontal in its direction.

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er.

(1043.) The salamander is constructed on the same model as the frog, with regard to all its internal organs; but it is provided with a tail. Its ear has no tympanum; but there is merely a cartilaginous plate laid over the fenestra ovale; there is no third eye-lid. The skeleton presents small rudimental ribs, but no sternum. This animal is remarkable for the power it possesses of reproducing the parts which have been mutilated, such as entire limbs; and even the eyes. In the newt, or aquatic salamander, the lungs have numerous processes, as in the chameleon, which terminate behind in an elongated bladder.

Müller has lately discovered that the frog, and several other animals of the same family, are provided with large receptacles for the lymph, situated immediately under the skin, and exhibiting distinct and regular pulsations, like the heart. The use of these *lymphatic hearts* is evidently to propel the lymph in its proper course along the lymphatic vessels. Their pulsations do not correspond in time with those of the sanguiferous heart; nor do those of the right and left sides take place at the same moment; but they often alternate in an irregular manner.

roteus

(1044.) The proteus anguinus, the siren, and the amphiuma, are remarkable for possessing both gills, like the tadpole, and lungs like the frog. They are, accordingly, adapted for living both in water and in air; and are the only animals that can strictly be said to be amphibious. The eye of the proteus is completely covered by the integuments, as it is in the mus typhlus.

Sect. IV.—*Comparative Physiology of Fishes.*

shes.

(1045.) Fishes are vertebrated animals with red blood, breathing by means of water applied to the gills, or *branchiæ*, which in them supply the office of respiratory organs. Their powers of motion are adapted to progression through the medium they inhabit. This design is conspicuous in the form of their bodies, the great muscularity of the tail, the shortness of their members, which are expanded into fins, and the coverings of the body, which are smooth and scaly. The oxygenation of the blood, being effected solely by means of the atmospheric air contained in the water they respire, takes place only to a small extent; hence the temperature of the body in fishes is not sensibly raised above that of the surrounding medium, and these animals display little energy either in their vital or their sensitive powers. The brain, accordingly, is of small size, and the organs of the external senses but little developed; they scarcely possess any organs calculated to convey accurate impressions of touch. Nature has denied them any vocal organs. The circumstances in which they are placed would appear to give little exercise to the sense of hearing; and the deep recesses of the ocean, where darkness eternally reigns, afford as little to that of sight. No lacrymal organs are wanted by animals immersed in a liquid medium. The voracity with which fishes devour their prey, leaves them scarcely any opportunity of discriminating its taste; and their tongue is not adapted by its structure for receiving the impressions of this sense. Neither can the sense of smell be exercised in the same degree as in animals respiring atmospheric air, through which odorous emanations are so extensively and so rapidly diffused. Exclusively occupied in the two great objects of animal desire, that of food and of progeny, all their movements appear exclusively directed to these ends; they appear insusceptible of attachment, and incapable of any but the lowest degree of intellectual developement.

Skeleton.

(1046.) The osteology of fishes presents a very complicated subject of study, not only from the great number of peices of which their skeleton is composed; but also from the great variety of forms exhibited in the different genera and species of this class. Fishes, with regard to their skeleton, admit of a great primary division into the cartilaginous and osseous. The former, or the *chondropterygii*, possess no real bones, but merely cartilages, having the form of bones, of a homogeneous and semitransparent substance, sometimes, however, as in the rays and sharks, presenting on its surface small calcareous granules, very closely compacted together. In a few fishes arranged under this division, as the sturgeon, and the chimera, we meet with several true bones in the head and shoulder, while the rest of the skeleton is cartilaginous. Even among the strictly osseous fishes, the density of the bones of some species is inferior to that of others, the calcareous substance, or phosphate of lime, being deposited in fibres, or layers, in the cartilage which serves as the basis of the bone. The truly osseous fishes have bones as hard and as dense as other vertebrated animals; they are even more homogeneous in their texture, and present no appearance of pores or of fibres, as are seen in the bones of the mammalia. We never find in them any medullary cavities.

(1047.) The spinal column consists of dorsal and caudal vertebræ only, those of the neck and sacrum being absent. The bodies of vertebræ have always a conical depression on both their surfaces; the double cone thus left by the junction of their margins being filled with a gelatinous fluid. These cavities generally, indeed, communicate together throughout the whole spinal column by apertures in the centre of each vertebra, at the apices of the cones. In the lamprey this opening is so wide, as to reduce the vertebral column to a mere series of rings, traversed from one end to the other by a ligament. The spinous processes are usually very long, and their roots form a canal for the passage of the spinal cord. Spinous processes are also frequently found on the opposite or abdominal side of the vertebræ; and these also form a canal for the protection of the aorta, which is admitted through it. The ribs are attached each to a single vertebra, and are frequently furnished with appendices adhering to them at one end, whilst the other end is imbedded in the muscles.

(1048.) The fins of fishes do not present much analogy with the bones of the extremities of quadrupeds, although such analogies have been sought with much eagerness. The fins are composed of parallel bones called rays, which are connected with others, called by Cuvier, *interspinal bones*, and by Meckel, *accessory spinal apophyses*. The sternum, where it exists, is composed of a series of bones, of various figures in different fishes; but which unite the lower extremities of the ribs. In the pectoral fin, or anterior extremity, are found bones somewhat analogous to the two bones which compose the scapula of reptiles; a styloid bone composed of two pieces, analogous perhaps to the clavicle and coracoid bone. The two bones corresponding to the radius and ulna are connected with a row of ossicula representing the carpus, and which support the rays of the fin itself.

(1049.) The posterior extremity, or base of the ventral fin, is composed of four bones, which may be considered as a pelvis; but these support the rays, without the interposition of any bones comparable to the femur, tibia, or tarsus.

(1050.) The bones of the head are exceedingly complex, and the mere enumeration of them would require a more lengthened discussion than can here be afforded. The bones composing the jaws, namely, the maxillary and intermaxillary, are not only moveable on the skull, but also on each other. The palatine, the pterygoid, and the tympanic bones, have also independent motions. A row of suborbitar bones also exists, different from what is met with in any other class. To the bones of the skull are joined also the opercular system of bones, which protect the gills, and are subservient to the motions which open and close them during respiration. The proper bones of the skull are placed in the midst of these four systems, and are very similar to those of reptiles, containing a receptacle for the brain, another for the labyrinth of the ear, and others for the eyes, and for the nasal cavities. The os frontis is composed of six pieces; the parietal of three; the occipital of five; each temporal of two; and the sphenoidal of five. Much ingenuity has been lavished in the attempt to discover analogies between these bones and the parts which compose the skeleton in the other classes of animals. Thus the opercular bones have been supposed to correspond to the ossicula auditus of mammalia; a notion which, although ably supported by Geoffroy St. Hilaire, may perhaps at first sight appear extremely fanciful and hypothetical, and which Cuvier represents as utterly unfounded.

Teeth.

(1051.) The teeth of fishes exhibit almost every possible variety in form, number, and situation. They may be distinguished, according to their position, into intermaxillary, maxillary, mandibular, vomerian, palatine, pterygoid, lingual, branchial, and superior and inferior pharyngean. Some fish have almost all these denominations of teeth; others a smaller number, and a few genera of fishes are entirely destitute of teeth. The teeth are generally of a conical and incurvated form, like so many hooks; sometimes the points are so small and united as to resemble a brush or file; others are round, or club-shaped; others present more flat surfaces, like a mosaic pavement. Their structure is always simple, being formed by a single pulpy membrane, which afterwards ossifies; and is, in process of time, replaced by a new tooth. This successive renewal of the teeth of fishes is continued during the whole period of their lives. The degree of mastication given to the food depends, of course, on the form and situation of the teeth.

(1052.) Deglutition is assisted by means of a membranous velum placed behind the anterior teeth. There is no appearance of salivary organs; unless we regard as such a soft and highly vascular organ found in the palate of the carp. This organ is highly irritable, and swells in a remarkable manner on the application of any stimulus; it perhaps performs the function of an organ of taste.

Digestive organs.

(1053.) The œsophagus is generally very short and capacious; it is continued into the stomach without any marked line of separation; and part of the food is often retained in the œsophagus undigested, until room can be made for it in the stomach. In a few fishes, the parietes of the stomach are muscular, so as to entitle it to be considered as a gizzard. The intestinal canal is generally very short; its internal coat is more or less villous; there is never any cœcum; the only distinction between the different portions of the canal is formed by a valve near its extremity; but this is not succeded by any dilatation.

(1054.) A remarkable structure is met with in the intestines of rays, sharks, and sturgeons; which present a spiral valve, or duplicature of the inner coat, running nearly the whole length of the canal. A great number of blind pouches, or *appendices pyloricæ*, as they are called, from their being more numerous in the beginning of the intestine, are generally found; their office appears to be to secrete a quantity of mucous fluid, probably analogous to saliva, or to the pancreatic secretion. In the sturgeon, these are short and united by vessels and cellular substance into one mass, which union becomes more close and compact in the rays and the sharks, constituting a real conglomerate gland, having a single excretory duct.

(1055.) In many fishes, namely, in the ray, shark, sturgeon, lamprey, and salmon, there are two passages opening outwards from the general cavity of the abdomen, at the sides of the termination of the intestine. The use of these passages is unknown.

(1056.) The liver is of considerable size, and placed more on the left side; great variety exists with regard to its shape and the number of its lobes in different fishes; its texture is softer than in quadrupeds and birds, and it contains a large quantity of oil. There is almost always a gall-bladder of greater or smaller size. The hepatic ducts are sometimes very numerous, and are successively joined to the cystic ducts. The mesentery is incomplete; and is often prolonged into folds containing fat, which folds may perhaps be considered as corresponding to an omentum. Although the lacteals are numerous, there are no lymphatic glands in the mesentery.

(1057.) The lymphatic vessels are very distinct in other parts of the body. Fohman has succeeded in injecting them in the gills. Several fishes have a urinary bladder, which is situated behind the rectum; in other instances there is merely a common cloaca, into which the ureters terminate. The kidneys are more voluminous than in any of the preceding classes, and are often joined together posteriorly; there are no suprarenal glands. The spleen is constantly present, and occupies various situations in the abdomen.

Circulation.

(1058.) The circulation in fishes is conducted upon a very different plan from what it is in reptiles. There is, as in warm-blooded animals, one complete circulation for the body in general, or a systemic circulation; and another for the organs of respiration; and besides this, a partial circulation for the hepatic system of organs; but what more particularly characterizes this mode of accomplishing that function is, that branchial circulation is the only one which is effected by a muscular apparatus, that is, by a heart. The systemic circulation has no such organ for communicating to it a mechanical impulse.

(1059.) The muscular apparatus for carrying on the circulation in fishes consists of four cavities, namely, the sinus venosus, the auricle, the ventricle, and the bulbus arteriosus; the three latter are inclosed in the pericardium, and may be said to constitute the heart, which is situated underneath the pharyngeal bones, and between the bronchial arches. The blood returning from the veins of the body and head, is collected in the sinus venosus, which transmits it by a single opening into the auricle, valves being interposed at the entrance. The auricle discharges its contents into the ventricle, which again propels it into the bulbus arteriosus, whence it proceeds along the bronchial arteries to be distributed on the gills. Thence it is returned by the bronchial veins, which unite near the spine to form a single arterial trunk corresponding in its office to the aorta, and distributing the blood, by a succession of ramifications, to every part of the body The veins from the digestive organs are collected into the vena portæ, which as usual ramifies through the liver; and there appears also, from the observations of Mr. Jacobson, to be in addition a lesser venal circulation, independent of either of the former, and analogous to what has already been observed in birds.

espira- ion.

(1060.) The vivifying influence of the air contained in the water which is applied to the gills of fishes, is quite as necessary for the continuance of their vital functions, as that of atmospheric air is to animals of the preceding classes; and fishes perish with equal rapidity as mammalia, when their natural element is withdrawn. This happens whether the water has been deprived of its air by boiling, or whether the absorption of air from the atmosphere is prevented by a body capable of intercepting it, placed on the surface of the water. It appears from the researches of Mr. Ehrmann, that some fishes, as the cobitis, swallow air, which passes along the intestinal tube, where it loses oxygen and acquires carbonic acid. Fishes taken out of the water are killed not so much from the want of oxygen, as in consequence of the drying of the branchiæ, which impedes the circulation of the blood through them. The water is taken in at the mouth, and after acting on the gills, which are filamentous organs, affixed in rows to the branchial arches, and protected by the operculum, is discharged through the branchial openings below. In the cartilaginous fishes there are several openings provided for the outlet of the water, at the side of the head.

ir blad- er.

(1061.) Most fishes possess a large bladder full of air, called the *swimming bladder*, placed immediately underneath the spinal column; it communicates with the œsophagus, and sometimes with the stomach, by a canal, called the *ductus pneumaticus*. In the carp, there are valves in this canal which only allow of the passage of air out of the bladder. In many fishes, especially in flat fish, no such air-bladder exists. Its figure is very various; its cavity is generally simple; but it is sometimes divided by a number of partitions. A glandular body is met with in the coats of this bladder, which probably secretes the air. The obvious intention of this instrument is to give greater buoyancy to the fish when this air is present, and to allow of a sudden increase of specific gravity by its escape. In by far the greater number of fishes, however, the air-bladder has no outlet whatever. In many fishes it is called the *sound*, and furnishes the best kind of jelly. Isinglass is the product of the air-bladder of the sturgeon. The air it contains is usually nitrogen gas, with a small proportion of oxygen and carbonic acid gases. The swimming bladder of fishes is regarded by many of the German physiologists as having some relations with the function of respiration; and as being the rudiment of the pulmonary cavity of land animals; the passage of communication with the œsophagus being conceived to represent the trachea. (Sec § 1022.)

ervous stem.

(1062.) The brain of fishes is remarkable for the smallness of its size, not only as compared with the total bulk of the animal, or with that of the nerves connected with it, but also with the cavity of the cranium, which it does not by any means fill, the space left being occupied by an oily secretion, and by loose cellular texture. The disparity is less observable in young fish; for it would appear that the growth of the brain does not keep pace with that of the rest of the body.

(1063.) The several parts which compose the brain of fishes are more detached from one another than in the higher classes, and are placed in a consecutive series. The foremost lobules give rise to the olfactory nerves, or rather appear as the bulbous enlargements of the origin of these nerves. The next in succession are solid lobes, which give origin to the optic nerves; behind these we find larger lobes containing a ventricle, with a striated eminence, at the back part of which are four smaller tubercles corresponding to the corposa quadrigemina. Behind these is the single lobule of the cerebellum, and below are two inferior lobes. The optic nerves pass before these lobes, and always decussate in their course to the orbits. Between these nerves, and in front of the inferior lobes, is the pineal gland. Behind the cerebellum are also two lobes, which may be termed the posterior lobes. There is, however, much difference of opinion as to the parts in the human brain to which these several portions of the brain of fishes are analogous.

Eyes.

(1064.) Great variety is met with in the size, position, and direction of the eyes of fishes. In general, however, they are large. There are neither eye-lids nor lacrymal organs, and the globe of the eye has but little mobility. In the ray and shark tribes, it is supported on the end of a moveable cartilaginous pedicle, articulated with the bottom of the orbit. The anabliss has the cornea divided into two by an opaque line, and two perforations exist in the iris, but there is only one crystalline lens, vetreous humor, and retina. The crystalline lens is completely spherical, and of great size, so as to leave but little space for the vitreous humor. It is composed of concentric laminæ, which are of greater density as they approach the centre. A falciform ligament, commencing at the entrance of the optic nerve, following its curvature downwards, and containing vessels and nervous filaments, is observable; its extremity is attached to the capsule of the crystalline lens. In some fish this ligament has a black colour, like the marsupium of birds. The sclerotica is often supported by osseous or cartilaginous plates, as in birds. The pupil is incapable of altering its dimensions; in the rays and flat fish, its border is fringed with palmated processes. The cornea is nearly flat, and there is but little aqueous humor.

(1065.) There is found in the eyes of fishes a peculiar body, the *membrana vasculosa Halleri*, having the shape of a horse-shoe, situated between the internal layer of the choroid coat, or *tunica Ruyschiana*, and the middle layer; it gives origin to a vascular membrane, called the *campanula*, which proceeds towards the lens, and has some analogy with the marsupium.

(1066.) The gastrobranchus appears to be wholly destitute of any organ of vision. In the blind murena, no trace of an eye can be perceived externally, but a rudimental organ exists beneath the skin.

Ear.

(1067.) The ear of fishes consists only of the parts belonging to the labyrinth; and these organs are generally suspended in a cavity of the cranium, which is a part of that in which the encephalon is contained. The two vertical semi-circular canals are suspended to the top of the skull by a vertical ligament. The oily or macilaginous fluid which surrounds the brain has free access to the cavities which surround the membranous labyrinth. The three semicircular canals are dilated into ampullæ, which receive the filaments of the auditory nerve. There is an appendix to the *sinus medianus*, or principal vestibular sac, termed the *utricle*, and a smaller one termed the *cysticule*. The hard calcareous bodies consist of one in each of these cavities, being three in number. There is no part corresponding to the cochlea.

(1068.) In the ray there is a spiral tube, wholly within the skin, which terminates in a kind of finestra ovale, and appears to be the rudiment of an external meatus.

Electrical organs.

(1069.) Many fishes present the extraordinary phenomena of the developement and accumulation of electricity in large quantities, which they have the power of discharging at pleasure, so as to give strong shocks to animals coming in electric contact with them, or forming part of the circuit of the discharge. This effect is often so powerful as to benumb and paralyse their assailants. The electric fishes which are known to possess this power in a high degree are the electric ray *(raia torpedo)*, the electric eel, *(gymnotus* *electricus*), and the *silurus electricus*, or *malapterurus electricus.* The first of these are met with principally in the Mediterranean Sea; the second in several rivers in South America; and the last in the Nile and Senegal rivers. Other fishes, however, are known to be electrical, although they have been less studied than those already mentioned, such as the *rhinobatus electricus*, *trichinus electricus*, and *tetrodon electricus.*

(1070.) The electrical organs of the torpedo consist of a great number of five or six-sided prisms, placed on each side of the head perpendicularly to the surface, and occupying the whole thickness of the animal. Each prism consists of a tube, with membranous sides, surrounded with nerves and blood-vessels, and containing a vast number of extremely thin plates, parallel to one another, but in a transverse position; the intervals are filled with a gelatinous fluid. Three large branches of the par vagum, and one branch of the fifth pair of nerves, are distributed to these organs on each side. The electrical apparatus of the gymnotus and silurus are disposed somewhat differently; they are two in number on each side, and extend the whole length of the fish from the head to the tail. One of these is situated deeply, and the other superficially; the two being separated by a membranous partition, and each being formed of horizontal plates, distant one-third of a line from one another, with septa passing perpendicularly between them, and directed from within outwards, and a fluid occupies the intervening spaces. Their nerves are derived from the intercostals, and are 224 in number.

(1071.) The identity of the agent called into play by these organs with electricity is beyond all doubt. The same bodies which conduct or intercept the transmission of the latter, have the same property with regard to the former; and shocks are propagated through a chain of several persons, when those at the extremities of the chain touch the fish. Electric sparks have been obtained by Walsh from the discharge of the gymnotus when passed through a strip of tin foil gummed to a piece of glass and cut through in the middle. Dr. John Davy[1] has obtained electro-magnetic effects from the torpedo, by the test of the galvanometer; and has also rendered needles magnetic by the electrical discharge from the fish.

(1072.) It appears that the power of producing these electrical discharges is quite voluntary, and dependent on the nervous influence; for it does not take place every time that the fish is touched, and it wholly ceases on the destruction of the brain, or the division of the nerves. The animal appears to have the power also of determining the direction of the discharges; and often, when irritated, it refrains from giving shocks. The destruction of the electric organ on one side does not interrupt the action of the opposite organ. Dr. Davy states, that the dorsal surface is charged with positive, and the ventral surface with negative electricity, and that unless both surfaces be simultaneously touched, no shock is felt; and Matteuci and Colladon[2] arrived at the same conclusion by experiments made with the galvanometer, as to the direction of the electric currents. Electric fishes, when vigorous, exert this power as strongly in the air as in the water. We are quite in the dark with regard to the theory of these phenomena. Matteuci imagines that the source of electric power in these fishes is in the brain; and that the purpose served by the complex arrangement of parallel plates, with intervening fluid, which composes the structure of the electric organs, is that of mere accumulation, analogous to the property of the Leyden phial.

Nasal cavities.

(1073.) What may be called the nasal cavities or nostrils of fishes, are placed generally in front of the head, and their openings are a valvular membrane or partition; behind this is found an elegantly plaited membrane, disposed in semicircular folds, on which the ramifications of the olfactory nerves terminate.

SECT. V.—*Comparative Physiology of Mollusca.*

Mollusca.

(1074.) The class mollusca comprehends all the variety of what are commonly called shell-fish, together with the animals, such as the slug, which resemble them in their anatomical character, but which are not furnished with shells. Their comparative anatomy has been studied with great care and diligence by Cuvier, whom chiefly we shall follow in our general description of this class.

(1075.) The mollusca have neither articulated skeleton nor vertebral canal. Their nervous system does not present a central spinal cord, but merely a certain number of medullary masses, dispersed in different situations in the body, and of which the largest, which may be designated the brain, is placed near the œsophagus, where it is connected with a collar of nerves that embraces that tube. The circulation is always double, like that of fishes, that is to say, the pulmonary circulation is always complete in itself, as well as the systemic. But the muscular ventricle, or heart, is not, as in fishes, placed at the commencement of the former, but of the latter; it impels the blood not into the branchial arteries, but into the aorta. The blood is either white or of a bluish colour; and it contains less fibrin than that of vertebrated animals. The veins probably perform the office of absorbents.

(1076.) The muscles are endowed with great irritability, and retain this property long after they are divided. They are attached to different points of the skin, which is smooth and moistened with a viscid liquor. The muscular actions produce contractions and inflexions of the different parts, and elongations of others, by means of which the animal is enabled to accomplish different kinds of progressive motion, whether in water or on land, without the aid of articulated members, or the advantage of solid unyielding structures, like the bones of the vertebrated classes. These movements, however, are necessarily less rapid and energetic, and less perfectly executed.

(1077.) A leading characteristic of the structure of the mollusca, consists in a muscular expansion, connected with the integument, which envelopes all the viscera, and is hence denominated the *cloak* or *mantle.* It assumes various forms in the different genera, being sometimes contracted into a flat disc, at other times being folded into a tube, or doubled into a sac, or expanded into the form of fins or oars. Most frequently we find a calcareous secretion formed on different parts of one or both of the surfaces of the mantle, which hardens and forms a layer of shell. Successive depositions take place, occasioning the enlargement of the shell in different directions; when the shell is wholly external to the animal, it serves for its habitation and protection; this is the case with the testaceous mollusca; in others, which have no such covering, (or the naked mollusca,) there frequently takes place an internal deposition of the same material, forming an internal shell. The calcareous matter is always intermixed, when deposited, with animal matter, which is sometimes in the form of a distinct membrane, and which has frequently a shining or irridescent appearance, constituting the substance known by the name of mother-of-pearl.

(1078.) Great variety exists in the organs of the digestive functions, as will be seen by the examples we shall give in speaking of the different orders established in this class by Cuvier.

1. *Cephalopoda.*

Cephalopoda.

(1079.) The various genera of sepiæ or cuttle-fish, are comprehended in this order.

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[1] *Phil. Trans.* for 1832 and 1834.

[2] *Séances de l'Acad. des Sciences,* Oct. 1836.

epia.

In these animals, the mantle is folded so as to form a sac enveloping all the viscera; its sides being more or less extended into fins. The head alone protrudes from the sac; its form is round, furnished with large eyes, and with long processes or tentacula, flexible in every direction, endowed with great muscular power, and having on the surface a great number of suckers, by which they are capable of adhering with great force to the objects to which they may apply them. These tentacula, or feet, are employed by the animal in walking, which it does with the head downwards; in swimming, which it executes with the head turned backwards; and also in seizing hold of bodies, for which action they are well adapted. Between the basis of the feet is placed the mouth, containing strong horny mandibles, resembling in their form the beak of a parrot. The excretions pass out by a funnel-shaped aperture, situated at the mouth of the sac, and near the head.

(1080.) The pulmonary organs consist of two branchiæ situated within the sac, one on each side, and having the figure of a fern leaf. The great vena cava, on arriving near them, divides into two trunks, terminating in two muscular ventricles placed at the base of the branchiæ, for the evident purpose of propelling the blood with more force into the branchial arteries. The branchial veins corresponding to these arteries, unite in a third ventricle situated near the bottom of the sac, and which sends the blood forwards through the aortic system as usual. Thus there may be said to be three separate hearts in the cuttle-fish, one aortic and two branchial. The water respired enters at the open margin of the mouth and passes out by the funnel-shaped aperture already described.

(1081.) There is found a tongue, of which the surface is bristled with sharp horny points; the œsophagus is dilated into a *crop*, and terminates afterwards in a gizzard, equally muscular with that of a granivorous bird. To this succeeds a third stomach, which is membranous, coiled into a spiral form, and receives the bile by two ducts from the liver.

k.

(1082.) A singular secretion is prepared by a gland in this animal, of a deep black colour, resembling ink, which, when effused, darkens the surrounding water to a considerable distance, and gives the animal an opportunity of escaping from its pursuers. The brain is large; a nervous ganglion surrounds the œsophagus. The optic ganglions are very large; and the nerves form plexuses in the abdomen and in other parts. The eye is similar in its conformation to that of the higher classes of animals; but the ear is constructed in a still simpler manner than that of fishes, having neither semicircular canals nor external meatus, but consisting merely of a membranous sac lodged in a cavity near the brain, in which a small cretaceous body is contained.

2. *Gasteropoda.*

astero-
da.

(1083.) The mollusca which have a shell consisting of a single valve, compose a numerous order, a familiar example of which occurs in the snail. The slug, on the other hand, belongs likewise to this order, although it has no external shell. Mollusca of this description are termed *gasteropodous*, because they crawl on a flat disc placed under the belly; the back is covered with the mantle, which is of greater or less extent, and secretes the shell. The head comes out more or less from the mantle, under which it is occasionally retracted, so as to be both concealed from view, and protected from injury. A small number of tentacula, from two to six, appear above the mouth, but do not surround it. The eyes are exceedingly small, and sometimes adhere to the head, sometimes to the base, or the side, or the extremity of the tentacula; but occasionally none are found. The position and structure of their respiratory organs varies in the different families of this order; and they are always situated under the last turn of the shell when this latter has, as is generally the case, a spiral form; and they receive the water either by a broad opening under the mantle, or by a narrower aperture, and often through a tube formed by the prolongation of the mantle, which is frequently protected by an indentation or tubular process of the shell. A further protection is often afforded by a flat, horny, or calcareous plate, which closes the shell when the animal has retired within it, and which is termed an *operculum.*

(1084.) Instead of branchiæ, the pulmonary gasteropoda are provided with cavities for the admission of atmospheric air, which they respire in its gaseous form. These cavities are opened and closed at the pleasure of the animal, the mechanism of their respiration consisting in these movements.

The stomach and intestinal canal are of very various structure in the different genera. In some, as the scyllæa, we find cutting teeth implanted in the coats of the stomach itself; in the pleurobranchus there are four stomachs, like those of ruminant quadrupeds. The aplysia is provided with a very capacious crop, which leads to a muscular gizzard, armed, moreover, with a number of cartilages of a pyramidal shape; a third stomach succeeds to this, having its inner coat lined with sharp hooks; and a fourth, shaped like a cœcum; and the intestines are, besides, exceedingly voluminous.

Many of the gasteropodous mollusca present the curious phenomena of the double hermaphrodite generation formerly adverted to, (§ 781.) Impregnation of the ova requires the union of two individuals, the female organs of each receiving the male organs of the other, and the fecundation being mutual. This is the case with the helix and the lymneus.

3. *Acephala.*

Acephala.

(1085.) The acephalous mollusca, so named from their having no head, have all the vital organs enclosed in the two folds of the mantle, which shuts like a portfolio, leaving apparent only the orifice of the mouth; but in some cases the mouth is here prolonged in the form of a tube. In almost every case each of the two sides of the mantle is covered by a valve of shell, so as to constitute a *bivalve* molluscous animal; in another tribe the shell is *multivalve.* The brain is situated immediately over the mouth, and consists of a certain number of small ganglions. The branchiæ have almost always a laminated form, the plates, generally four in number, being covered with a net-work of blood-vessels. The mollusca of this order are unprovided with teeth, the food brought by the water being received into the mouth, and swallowed in its original state, whence it passes into the stomach; sometimes there are two successive cavities performing the functions of the stomach; the intestine is of various length. The liver surrounds the stomach, and pours its secretion directly into the cavity by several apertures.

Foot

(1086.) A large fleshy process, resembling in appearance a tongue, and which has been compared to a foot, projects from the body, and by the varied movements of which it is capable, enables the animal to perform a slow progressive motion. Muscles are also provided for closing the shell, and they generally pass directly from one valve to the other; sometimes there are two muscles, but commonly only one. The valves are separated by the force of an elastic ligament placed at the extremity of the hinge, which is called into action when the muscles that close the shell are relaxed.

Byssus.

(1087.) The threads, or byssus, spun by many acephalous mollusca in order to attach themselves to rocks, as a ship is moored by her cables, is another peculiarity in these animals, and particularly of the genera mytilus and pinna.

(1088.) In many mollusca of this order the rectum passes through the cavity of the heart, and this latter organ receives the blood from the veins by means of two auricles.

Some acephala are hermaphrodite; but the union of the sexual organs necessary for fecundation takes place in a single individual. This occurs in the holothuria.

Ascidia.

(1089.) One of the most singularly constructed of the animals referred to this division of mollusca is the ascidia. The mantle and its envelope, which is a thick and cartilaginous tunic, form together a sac, everywhere closed, excepting at two orifices, the one corresponding to the termination of the intestine, the other leading into a cavity, of which the sides are the branchiæ, and at the bottom of which is placed the mouth, the principal viscera subservient to nutrition occupying a second cavity, and the heart being lodged in a third. The principal nervous ganglion is situated between the two external orifices of the sac.

SECT. VI.—*Comparative Physiology of Articulata.*

Articulata.

(1090.) This great division of the animal kingdom comprises all those tribes possessing what may properly be called an external skeleton; that is, a series of rings or hollow cases, of a hard texture, which enclose all the important organs of the body, and which, by their muscular connexions, allow of various kinds of movements, at the same time that they afford protection to all the softer tissues of which those organs are composed. The best idea that can be formed of this mechanical construction may be obtained by examining the body and the limbs of a lobster, in which it will be seen, that contrary to what obtains in vertebrated animals, the harder parts are external, and the muscles are within them, a construction allowing of very free movements of the limbs.

Nervous system.

(1091.) A remarkable degree of uniformity prevails with regard to the distribution of the nervous system in all these animals. The brain, which is situated above the œsophagus, but is still in the head, as in the higher classes of animals, is exceedingly small; and after sending out filaments of nerves to the different parts about the head, is connected with a double nervous cord, which encircles the œsophagus, and runs along the under side of the animal, being joined at intervals by nodules or ganglia, from which, as from new centres, other nervous threads radiate, and are variously distributed to the different vital organs, and to the limbs. Each of these nervous ganglia appears to perform the office of a subordinate brain in relation to the system of nerves which proceeds from it, and to the parts of the body supplied by those nerves, so that when the animal is divided into several portions, each portion seems to possess its own independent vitality. The form and structure of the digestive organs is very various; but jaws are always found, and their motion is lateral instead of vertical, as in vertebrated animals.

1. *Annelida.*

Annelida.

(1092.) The first class of articulated animals are the annelida, or worm-shaped animals. They are remarkable for possessing red blood, which circulates in a double system of complicated vessels, without any heart, or muscular ventricles. The body is soft, more or less elongated, and composed of a great number of segments. The foremost of these, which may be regarded as the head, contains the largest of the ganglia, or brain, the mouth, and the principal organs of the senses. The branchiæ are generally external, and sometimes uniformly spread on the surface of the body; and at other times are confined to the anterior divisions. Tufts of hair or bristles supply the place of feet. The mouth is either furnished with hard jaws, or else extended in the form of a tube.

(1093.) The leech, which is referable to this class, has a very capacious stomach, nearly of the size of the whole body, or rather a series of pouches, or dilatations proceeding from each side of the central cavity.[1] Tentacula situated on the head, are their principal organs of touch; and the small black points, observable in some tribes, have been regarded as organs of an imperfect kind of vision. The earth-worm has a remarkably complicated apparatus for circulation, consisting of a great number of dilatations of the dorsal vessel, forming a series of hearts.[2]

2. *Crustacea.*

Crustacea.

(1094.) The articulated form is more perfectly developed in the crustacea than in the annelida. Their blood is white, and is circulated by the aid of a muscular ventricle, or heart, situated in the back, propelling it through an arterial system; whence it returns by a system of veins, which collect in a trunk passing along the lower part of the abdomen. In some species the heart assumes a very elongated shape. There are always organs termed *antennæ*, or feelers, situated in front of the head; and these are generally four in number. The jaws are of complicated structure. It is only in a few species that an internal ear is met with, and it then consists of a sac full of fluid, in which a calcareous concretion is contained. The eyes are generally two in number, often placed at the end of pedicles, and consisting of a great number of facets, each provided with a separate cornea, retina, and branch of the optic nerve; and the whole constituting what is termed a composite eye. The branchiæ are of a pyramidal form, composed of plates, or filaments, or feathery tufts, generally situated at the base of the legs.

Lobster.

(1095.) The larger genera of this class, as the lobster, have a horny stomach, with strong teeth implanted in its coats, for the evident purpose of breaking and bruising the shells that are swallowed. All these animals cast off their shells several times in the progress of their growth, a new shell being successively formed of larger dimensions than the preceding, and adapted to the increased size of the animal.

3. *Arachnida.*

Arachnida.

(1096.) The third class of articulated animals, or the arachnida, have been separated from that of insects with which they had been before associated; being distinguished by the following peculiarities in their conformation and economy. They have a distinct circulation of the blood by means of an elongated dorsal vessel performing the office of a heart, propelling its blood into a system of arteries, and receiving it back again from a system of veins. They are without antennæ, but are provided with palpi. They have pulmonary cavities subservient to the respiration of atmospheric air. The head is united with the trunk without the intervention of any neck. The mouth is armed with jaws; and there are several simple eyes situated on the upper part of the head.

4. *Insects.*

Insects.

(1097.) Nothing can exceed the endless variety of forms displayed by this class of the animal creation. Their internal anatomy and economy, however, present many points which are common to the whole class. There is no other trace of a heart, than a long cylindrical tube extending along the back, and termed the *dorsal vessel;* but which seems to be closed on all sides, and neither to give out, nor to receive communicating branches of any sort. This vessel appears to contain a fluid, which is irregularly undulated backwards and forwards, by a kind of pulsation, or occasional contraction of one part of the canal, and dilatation of another. It had been supposed, in the absence of any visible blood-vessels, that nutrition in insects is performed by a kind of gradual transudation, or *imbibition*, as it has been termed. Professor Carus, however, has lately made the discovery of a distinct circulation in the vessels of the larvæ of several insects, and other observers have found a system of partial circulation in even later periods of insect life. But, in general, in the last stage of transformation, all these vessels, excepting the dorsal vessel, become obliterated.[1] There being neither branchiæ nor pulmonary organs where the nutritious fluids could receive the vivifying influence of the air, a complex mode of respiration is resorted to. Apertures are found in different parts, generally along the sides of the body, and which are called *spiracles* or *stigmata*. These are the commencements of elastic tubes, which remain continually open, and which are subdivided and ramified like the blood-vessels of other animals, for the purpose of conveying air to every part of the system. These tubes are termed *tracheæ.*

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[1] See a description and delineation of this structure in the Bridgewater Treatise *on Animal and Vegetable Physiology,* ii. 103.

[2] Ibid. ii. 255.

(1098.) Insects are unprovided with glands for effecting secretions; that purpose being answered by means of long spongy vessels, which appear capable of absorbing the materials they require from the general cavity in which they float.

(1099.) The temperature of insects, like that of other animals said to be cold-blooded, varies with that of the surrounding medium; but is generally one or two degrees higher. In bee-hives and ant-hills, a much higher temperature prevails. This is proved by an elaborate series of experiments made on the temperature of insects, and its connexion with the functions of respiration and circulation, by Mr. Newport.[2]

(1100.) Their nervous system is formed upon the general model already described, (§ 1091.) The digestive organs admit of the greatest possible variety, according to the habits and particular kinds of food consumed. To specify all these diversities would far exceed the limits assigned to us in this work. The external organs connected with the limbs, the antennæ, the mouth, and the different functions of sense, fall more properly under the consideration of the naturalist, inasmuch as they furnish the best characters for the distinction of genera and species, and for perfecting their systematic classification. The subject is rendered infinitely more complex in consequence of the metamorphoses which the same insect undergoes in passing through the different stages of its existence, from the *egg* to the *larva,* the *nympha* and the *imago*, or the perfect insect. But for the history of these changes, we must again refer to the naturalist, to whose province it more strictly belongs to record them. We must content ourselves with mentioning in this place a few of the more striking peculiarities of internal conformation which are observable in some of the insect tribes.

Digestive organs. Ruminant stomachs.

(1101.) The first that we shall point out is, the remarkable structure of the digestive organs of the orthoptera, an order of insects which comprehend the blatta, or cockroach, and the mantis or leaf insect, the ear-wig, the locust, the grasshopper, and the cricket. Their stomachs bear some analogy to those of ruminant quadrupeds, in complication at least, if not in office. The first stomach, or crop, is membranous; to this succeeds a muscular stomach, or gizzard, the internal surface of which is armed either with scales, or with horny teeth. Around the pylorus there extend two or more blind pouches, furnished at their extremities with numerous vessels conveying bile. Many similar biliary ducts are inserted in the course of the intestinal canal. It has been strongly suspected that the insects in which these complex stomachs are found, actually possess the power of ruminating their food.

(1102.) The abdominal cavity of the working bee presents us with two stomachs, together with the intestine and the poison bladder. The anterior stomach in which the œsophagus opens, is the receptacle for the honey, which is occasionally returned into the mouth in order to be stored in the honey-cells, as a magazine of food for the winter. The next stomach is destined to contain the pollen, or material gathered from the antennæ of flowers. Its inner coat has a great number of circular folds. Wax is a secretion of a peculiar kind from the bee.

(1103.) The alimentary canal of the caterpillar, before transformation, consists of a straight and capacious tube, of which the anterior portion is somewhat dilated into what may be considered as the stomach; and of which the posterior portions forms a cloaca; the biliary vessels, which are four in number, and very long, are inserted very far behind. When the caterpillar is transformed into a butterfly, this alimentary canal is much diminished, both in its diameter and length; the first stomach, or crop, is situated on the side of the tube; there is next a second stomach full of irregular dilatations, a slender but long intestine, and a cœcum near the cloaca.[3]

(1104.) The nervous system undergoes corresponding changes during the transformations of insects, the ganglia uniting in several places, so that their number is much diminished.[4] The external senses of insects have for the most part a considerable range of action. Organs of vision are almost constantly present, but those of the other senses are but imperfectly known. The principal organs of touch are the *antennæ,* which probably also perform other offices relating to sensation, of which we have no certain knowledge.

Sect. VII.—*Comparative Physiology of Zoophytes.*

Zoophytes.

(1105.) The animals which occupy the lowest division in the scale of life, and constitute an approach to vegetable, namely, the class of zoophytes, present us with much simpler forms of organization than any of those which have passed under our review. Yet amongst these we may trace gradations in the mode in which the more refined organs of the animal economy successively disappear, and their functions are supplied by other parts, and also in the gradual simplification of those functions, till we appear to arrive at an approximation to mere vegetative existence. The great characteristic of the more perfect animals, the circulation of the fluids in vessels which distribute them to every part for the purposes of nutrition and secretion, is wanting in zoophytes; or if any traces of a circulation can be discovered, it is exceedingly partial and limited in degree. There is a well marked disposition in all the organs to assume a symmetrical arrangement about a common centre; being either disposed in radii proceeding from that centre, or arranged in a uniform manner round the circumference of a circle. In those instances in which a nervous system can be traced, which is the case only among the higher order of echinodermata, the disposition to assume this radiating form is particularly observable.

(1106.) Many amongst the lowest orders present us with the singular spectacle of compound animals, associated in great numbers for the purposes of a common defence and habitation, and having even nutrition in common. These more particularly constitute an approach to the vegetable kingdom.

1. *Echinodermata.*

(1107.) The zoophytes arranged in this division, which are chiefly the asterias, or star-fish, the echinus, and the holothuria, present us with some appearance of an external skeleton, or hard encasement, consisting of parts which are often articulated together, an imperfect vascular system, and the appearance of a system of nerves.

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[1] The dorsal vessel of the sphinx ligustri is delineated in the Bridgewater Treatise *on Animal and Vegetable Physiology*, ii. 245.

[2] *Philosophical Transactions* for 1837, p. 25.

[3] These successive conformations of the digestive organs, in the *sphynx ligustri*, or privet hawkmoth, are delineated in the Bridgewater Treatise on *Animal and Vegetable Physiology*, ii. 217.

[4] Ibid. ii. 547.

Asterias. (1108.) The rays of the asterias are composed of numerous pieces, which have been compared to vertebræ, are slightly moveable upon one another, and allow of a slow flexion of the entire ray. It is hollowed below into a longitudinal groove, abounding in perforations for the passage of numerous rows of short tentacula, which perform the office of feet, for the progressive motion of the animal, and which also absorb water, and convey it into the general internal cavity for the purpose of respiration. The centre of the star is occupied by a large stomach, the entrance to which, or the mouth, is below, and which sends out two prolongations, or cœca, to each ray; these are ultimately ramified into minute vessels, suspended by a membrane which performs the office of a mesentery.

Echinus. (1109.) The structure of the echinus is still more complicated. The calcareous covering of the body has a globular shape, but is composed of several angular pieces joined together, and perforated by rows of lobes, through which the short feet, or tentacula, protrude. Besides these, there are a multitude of spines articulated to the surface of the shell, and subservient to voluntary motion. The mouth is armed with five teeth, inserted in a complicated apparatus of jaws, resembling a pentagonal lantern, provided with numerous muscles, and suspended over the great opening in the centre of the lower surface of the shell. The intestinal canal is of great length, and forms a spiral tube attached to the interior of the shell by a mesentery. A double vascular system extends the whole length of this canal, and is partly spread over the mesentery.

Holothuria (1110.) The holothuria resembles in its structure the echinus, but it has a cylindrical instead of a globular form. The respiratory organ is ramified like the branches of a tree, and fills and empties itself at the pleasure of the animal. The mouth has no teeth, and is only protected by a circle of calcareous plates. The intestine is very long, and makes many folds, being also attached to the sides by a mesentery. A partial circulation takes place in a double system of a very complicated arrangement of vessels, which has relation exclusively to the intestinal canal, and of which some of the branches are interlaced with the arborescent respiratory tubes already described.

2. *Entozoa.*

Entozoa. (1112.) Very little is known concerning the physiology of intestinal worms; the information that has been collected being chiefly of a negative kind. They have no visible respiratory organs, and no apparent nervous system or organs of sensation; and still less can we discover any traces of a circulation. The only very distinct organs are those belonging to the functions of nutrition and of reproduction. Some naturalists, indeed, allege that they have detected some filaments of nerves; but the real nature of these filaments is still very doubtful.

(1113.) The alimentary canal may in most intestinal worms be recognised without much difficulty; it is sometimes enclosed in an abdominal cavity, but at other times apparently passes through the solid parenchyma of the body. In some, as in the tænia, or tape-worm, we may discern ramified vessels for the distribution of the nourishment; but these are not seen in others. The simplest animal of this tribe is the globular hydatid, which consists altogether of a vesicular sac filled with a transparent fluid, and with an indistinct mouth; but without any other apparent external organ. This tribe of entozoa exhibit the simplest example of the gemmiparous mode of reproduction; the young appearing as gemmæ, or buds, which at certain periods spout from the homogeneous parenchyma composing the body of the parent, and by a sort of vegetative growth, gradually assume the form of the original animal, and are detached when capable of exercising an independent life.

Some of the entozoa, as the tænia, or tape-worm, are capable of being multiplied like plants, by division; each segment resulting from the division being converted into an independent animal, acquiring whatever parts may have been deficient, and after a time admitting of further subdivision, with a repetition of the same phenomena.

3. *Acalepha.*

(1114.) These are either fixed on rocks, or float in the sea; they exhibit more or less of a fibrous texture, and contain vessels which are excavated out of the substance of the body itself, and are not contained in any distinct cavity. Acalepha.

(1115.) The actinia, or sea anemone, is provided with numerous hollow tentacula surrounding the mouth and stomach. The space between the stomach and the outer skin is divided into compartments by vertical partitions, and the fluid contained in these compartments may be projected into the tentacula so as to render them turgid. Actinia.

(1116.) The medusa has a hemispherical form, and a gelatinous consistence. The mouth, which is situated in the centre of the flat disc below, is surrounded by fringed tentacula. It leads into a singularly-shaped cavity, which is the stomach, formed of four arches proceeding like radii from the centre, and terminating in tubes which are variously divided, and the branches derived from them freely communicating with one another by anastomoses. These are apparently for distributing the nourishment which has been prepared by the stomach, but not for any real circulation. There are four large cavities in the body which appear to be subservient to respiration. Medusa.

(1117.) In some species, forming the genus *rhizostoma* of Cuvier, there is no central mouth, but a canal commences by an open orifice from the extremity of each of the fringe-like processes of the tentacula, and these, uniting with others in their course upwards, form at length a single tube or œsophagus, which terminates in the central stomach already described. Rhizostoma.

Most of the animals of this order, which are found fixed on rocks, are propagated by means of spores or gemmules, constituting one of the modes by which the gemmiparous form of reproduction is effected. These gemmules are minute bodies, formed either on the surface or in some special internal organ of the parent, and which are immediately detached and swim with a spontaneous and independent motion in the circumambient fluid, by means of cilia or short filaments, which are in rapid and incessant vibration. They pursue these motions for a certain time till they find a convenient place for their future habitation, where, when they are once fixed, they generally remain ever after, growing to the dimensions and exercising all the functions of the parent animal. In the acalepha, which are not stationary, the gemmules retain their liberty of moving during the whole period of their existence.

4. *Polypi.*

(1118.) The organization of this numerous order of zoophytes, presents, in every essential particular, great uniformity, and bears a great analogy to that of the actinia. The gelatinous sac or tube, constituting the digestive cavity, is closed at one end, the opening at the other end being the mouth, which is surrounded by a circle of tentacula; and the nutritive fluid passing by imbibition through the coats of the general sac or stomach for the purpose of nourishment. The hydra may be taken as the type of this tribe of animals. It consists of a mere stomach provided with flexible tentacula for catching food and for progression. This sac may be inverted or turned inside out, without detriment to the animal, digestion being then performed by the new cavity, which is the result of the operation. These animals present the simplest examples of gemmiparous generation, (§ 777). Polypi.

No further discovery can be made respecting the organization of these animals, even by applying the microscope, which shews only a semitransparent substance interspersed with opaque grains. The greater number secrete on their outer surface a calcareous or a horny substance, which serves for their mechanical support, but at the same time fixes them on the spot to which they adhere.

Aggregate olypi.

(1119.) The most remarkable feature in their history is their disposition to congregate together in vast numbers, so as to compose by their united architecture whole rocks and even submarine mountains, rising from the bottom of the ocean. Some of these animal republics exhibit amongst the individuals thus associated together communications of nutritious vessels, so that the materials for the sustenance of each passes into the bodies of the neighbouring polypi, and is applied to the purposes of their economy. All these fixed polypi are propagated by spores or gemmules in the manner already described in our account of the stationary acalepha.

5. *Infusoria.*

nfusoria.

(1120.) These being all microscopic animalcules of extreme minuteness, it is scarcely possible to arrive at any exact knowledge of their internal organization or economy. Many, and probably all, are possessed of distinct organs for the reception of food, for reproduction, and for voluntary motion; but conjecture alone can fill up the imperfect outline, or suggest any plausible hypothesis as to their powers of sensation, which, however, we are unwilling to refuse to any being which appears to possess the properties and attributes of animality, especially since the splendid discoveries of Ehrenberg have made us acquainted with the complex organization observable in some of the minutest of this prodigiously diversified tribe of beings. It is remarkable, indeed, that those very animalcules, as the monads, which had been ranked by naturalists among the *agastrica*, or beings totally without alimentary cavities, are now found to have a very considerable number of stomachs, and to be entitled accordingly to the title of *polygastrica*.

It is chiefly amongst the various tribes of infusoria that the simpler modes of generation, such as that termed *fissiparous*, are exemplified. In the monas, for instance, a groove is seen to form around the equator of their globular bodies, which groove, gradually deepening, changes their form to that of an hour-glass, and the connecting ligament of the two portions being soon broken, the segments move away from one another, each commencing its independent existence, and being capable of performing all the functions of the undivided monad. In the bell-shaped vorticella, the division commences at the mouth or wide extremity of the bell, and gradually extends in a longitudinal direction towards the insertion of the stem, dividing the body into two equal portions, each being now a distinct and individual animal. The gonium divides itself into four instead of two portions, each portion being again subdivided into four others, the new animalcules assuming rapidly the dimensions and appearance of the one of which they originally formed a part. Other species are propagated by means of gemmules; and some of the infusoria are apparently oviparous.

CHAP. XXIII.—HISTORY OF PHYSIOLOGY.

History.

(1121.) The study of the history of any science furnishes to the mind a body of knowledge not merely ornamental or superfluous, but one that is fraught with instruction and utility, and is conducive to the just comprehension of the subject to which it relates. It is scarcely ever necessary, indeed, for the understanding of any proposition, that the student should follow the same laborious course and travel through the same tortuous mazes by which the discovery had originally been achieved; for the acquisition of any body of knowledge already systematized by the labours of our predecessors, is in general most readily attained by the synthetic method. But as soon as this point has been reached we can conceive no course of study more calculated to improve that knowledge, and to invigorate the faculties by which it may be extended and perfected, than reverting to the analytic process, and following the series of discoveries in the order in which they have actually occurred. From an historical survey of the successive steps by which science has proceeded from a rude origin to its present state of advancement, and which mark its varied progress and even occasional retrogressions at different periods, according to the prevailing disposition of the age, either to a servile submission to authority or to the hasty adoption of crude and visionary theories, we are enabled to derive most important rules for the conduct of the understanding in the search after truth.

The history of each particular branch of science may, indeed, be regarded as a separate chapter in the history of the human mind. It indicates the sources of its activity and of its strength, and also of its weakness and fallibility; it holds out the most powerful incentives to exertion; it exhibits much to admire and to emulate, and, at the same time, discloses enough to check pride and teach humility.

(1122.) The history of physiology must necessarily comprise a large portion of the history of anatomy, which consists in the mere knowledge of the organs and minute structure of the body, such knowledge being, in fact, the foundation on which the higher science of the philosophy of life is built. It is scarcely possible, indeed, to study mere organization, without extending our views to the functions that we see performed, and to the energies that are exerted by the living organs. Our object will therefore be in the present place, to inquire how far these higher qualities of mind have been displayed by the cultivators of this department of knowledge at different periods, so as to mark the progress of the philosophy of life, as contradistinguished from the more mechanical, though equally useful labours of the mere anatomist.

Earliest periods.

(1123.) The phenomena which constitute the subjects of physiological inquiry must, indeed, have attracted the attention of mankind long before any accurate knowledge had been acquired of the structure of the organs whose actions give rise to these phenomena. Life in its different forms must have been familiar to all; and every savage and warlike people must have been conversant with the diversified aspects of death, which they inflicted in such various modes. Speculations on the nature of the vital principle, and the physiological conditions on which it is dependent for its origin, maintenance, and decay, must have been formed and pursued in every state of society, removed but one degree from barbarism; and such speculations must have stimulated inquiry into the internal mechanism with which that principle is associated, and the hidden springs which regulate its course.

(1124.) Opportunities must frequently have occurred in the rudest ages, of observing the different parts of the structure of the bodies both of men and animals. The curiosity even of the savage could not fail to be attracted by the remarkable appearance of the internal organs, in the animals which he slaughtered for food, or prepared for sacrifice. Although deterred from the actual examination of the human body, by an instinctive repugnance, or superstitious terror, various casualties occurring in battle, or arising from accidents, would occasionally afford an insight into the human frame. Human bones, and sometimes entire skeletons, would often present themselves to those who revisited the fields of carnage. Thus would the principal bones, and the most conspicuous viscera of the human body, soon become known, and they would be designated by particular names. Evidence to this effect may be collected from the rudest and most ancient languages; from which we may infer that a certain progress must have been made in this kind of knowledge, long before it had been so arranged and methodized as to deserve the name of a science.

Amongst the Egyptians.

(1125.) The prevailing custom amongst most of the ancient nations, of consigning all dead bodies to destruction by fire, was one of the greatest obstacles to the advancement of anatomical and physiological knowledge. But opportunities were on the other hand afforded of learning the structure of certain animals, by the religious rites, during the celebration of which these animals were sacrificed, and especially by the examinations which were made by the priests of the yet palpitating entrails of their victims, for the purpose of prognosticating future events. Inferences were thus drawn by analogy as to the organization and functions of the human body. The Egyptians, indeed, who composed the most ancient nation of whose manners and customs we possess any authentic records, were supposed to have acquired considerable knowledge of the human structure from the practice of embalming the dead. This operation was performed by a particular class of men, and consisted in taking out a portion of the viscera, washing them with antiseptic fluids, and filling the cavities with aromatic substances. But as this process appears to have been conducted in the rudest manner, it required no skill in anatomy, and was but little calculated to improve the science. It was in the hands of a few persons only; and such was the contempt and abhorrence in which these persons were held by their countrymen, that whatever knowledge they might have acquired by the practice of their art, was not likely to be communicated to others.

The Greeks

(1126.) Whatever splendour may have attended the pride of power or extent of empire in these rude and unenlightened ages, the dawn of science was coeval only with that of liberty. The same energies by which man had thrown off the yoke of tyranny, animated them likewise with the desire of knowledge; and nations had no sooner emancipated themselves from despotism, than they began to emerge from barbarism and ignorance. The Greeks, who were the most free, were also the most polished of all the nations of antiquity, and far excelled them in every species of science and of art. So great was the ardour of their philosophers in the pursuit of knowledge, that they frequently travelled into distant countries to collect useful information, and impart it to their pupils. Even in the time of Homer, the Greeks seem to have possessed much general knowledge both of anatomy and physiology, as may be collected from the writings of that poet. He relates that the stone which was hurled at Æneas by Diomed, not only crushed the thigh-bone, but also tore the ligament of the acetabulum. Merion is represented as being wounded in one of the large veins which return the blood to the heart, or venæ cavæ; and Ulysses aimed a blow at the Cyclops at the part where the liver adheres to the diaphragm. It has even been supposed that Homer has purposely often wounded his heroes that he might have opportunities of displaying by the minuteness of his descriptions, his accurate acquaintance with anatomy.

Pythagoras.

(1127.) But though curiosity was roused, and a multitude of detached facts had been observed and collected, it was long before the proper methods of investigation were known, and the true principles of inquiry established. Although it appears that the studies of anatomy and physiology were prosecuted with considerable ardour in the school of Pythagoras, yet as they were regarded merely as a part of natural history, the information relating to these subjects was not sufficiently connected or concentrated to be embodied in one science. Alcmeon and Empedocles, who cultivated anatomy, belonged to this school; but the most remarkable of the pupils of Pythagoras, belonging to the Eleatic sect, was Democritus of Abdera, a man whose eccentric manners, as well as penetrating genius, and undisguised contempt for the follies of mankind, have procured him so much celebrity. He is said to have devoted considerable time to the dissection of animals, especially with a view to discover the origin and course of the bile. His fondness for seclusion, and his perseverance in a pursuit which appeared to his countrymen to be without any rational object, led them to suspect the soundness of his intellects; and Hippocrates was sent to visit him in his solitary abode. He found the philosopher seated on a stone, under the ample shade of a plane tree, with a number of books arranged on each side, one on his knee, a pencil in his hand, and several animals which he had been dissecting lying before him. His complexion was pale, his countenance thoughtful; at times he laughed, at times shook his head, mused for a while, and then wrote, then rose up and walked, inspected the animals, sat down, and wrote again. Hippocrates, who perceived the nature of his inquiries, observed him for some time in silent admiration, proclaimed to the bystanders the importance of his researches, and declared to them his regret that want of leisure from his own professional employments did not allow him to engage in similar pursuits.

Democritus.

Hippocrates.

(1128.) But it was only from men whose minds are capable of enlarged views, and can perceive the bearings and connexions of the several parts of the subjects they embrace, that a powerful impulse is given to science, such as to make it almost the creation of their hands, that it is raised to its proper rank among the departments of human knowledge. Such was the vigorous mind of Hippocrates; and so great was the improvement which medicine derived from his genius, that the foundation was thus laid for the more rapid progress of all the sciences connected with it in succeeding times. Hippocrates was born in the island of Cos, in the first year of the 80th olympiad, or 460 years before Christ; an æra which is therefore remarkable in the history of medical science. It appears that at that period a knowledge of medicine had been in a great measure hereditary in certain families, amongst whom the information which had descended from the successive generations was thus retained and augmented. This was the case in the family of Hippocrates, who is said to have been the fourteenth descendant from Esculapius, on his father's side; while his maternal ancestry could be traced to Hercules. He had been instructed in all the learning of those times; but particularly dedicated himself to the cultivation of medicine, which he formed into a distinct science, collecting and arranging all the information on the subject that was then known. Not satisfied with the knowledge which he could acquire in his native place, he travelled for several years through different parts of Greece and Asia Minor. He visited the temple of Diana at Ephesus, and was at the pains of transcribing and arranging the records of cases and of successful methods of cure, which it was the custom to deposit on tablets in these temples. On retiring to his native island, after the laborious proofs he had given of his diligence and ardour, he continued to exercise his profession, and enjoyed the highest and most extensive reputation. Such was the estimation in which his talents were held, that even princes were solicitous to allure him to their courts; but he was so strongly attached to his native country, that he resisted every temptation which the splendour or the favour of monarchs could hold out.

(1129.) Excepting one or two particular treatises, which bear his name, but the authenticity of which is dubious, the writings of Hippocrates are to be regarded rather as medical than physiological; but he seems to have been the first who formed a clear conception of the value of anatomy and physiology as the basis of medical reasoning. Originality of thought, combined with accuracy of observation, forms the characteristic feature of his writings; which contain, however, many traces of the Pythagorean philosophy, with which he seems to have been early imbued. He formed the bold conception of the existence of a principle, which he calls φυσις, or nature, exercising a general direction and superintendence over all the actions and movements of the body, and endowed for that purpose with a species of intelligence directed to beneficial ends. As subservient to this great and prime agent, he imagined that the functions were carried on by means of other subordinate powers or faculties; and also that they were subjected to the influence of the stars. He regarded the body as being composed of three kinds of substances, namely, solids, fluids, and spirits, and ultimately resolvable into the four primary elements of earth, water, air, and fire, the predominance of each of which in particular individuals gave rise to the prevailing temperaments, characterised by the peculiar combinations of the four qualities of dry, moist, cold, and hot. Hence arose his doctrine of temperaments, already noticed, (§ 862). The anatomical details which are interspersed throughout his works are numerous, but do not exhibit any profound knowledge of the subject, besides being in many instances incorrect. The confession which he made on his visit to Democritus shews that he had not devoted any considerable portion of his time either to physiology or to practical anatomy. It is very apparent, indeed, that he never dissected a human body; and much could not be learned from the occasional dissection of brutes. So far was he from having any idea of the real nature of the circulation of the blood, which some have done him the honour to suppose he had discovered, that he seems to have imagined that the arteries contained air, and he was at a loss to determine whether the veins took their origin in the liver, the heart, or the brain. He includes under the same name the ligaments, the tendons, and the nerves, and makes no distinction between their respective offices in the economy. But these imperfections were more to be imputed to the unavoidable disadvantages of the times, than to his own deficiency either of industry or of talent; for wherever he had opportunities of displaying these qualities, and of exerting the whole force of his original mind, he far surpassed all his cotemporaries. Hippocrates must indeed be regarded as the father of physiology, as well as of medicine; and his name will ever be cherished by posterity, as one of the most illustrious in the annals of science.

ocrates.

(1130.) Amongst the Athenian philosophers who paid attention to physiology, Socrates must not be passed over in silence; since he cultivated the science with a view to establish upon it, as upon the most solid foundation, the principles of natural theology. Plato, the friend and pupil of Socrates, likewise devoted a portion of his time to the study of animal structures, and indulged in a variety of fanciful speculations concerning the uses and functions of the vital organs.

lato.

ristotle.

(1131.) Aristotle, the tutor of Alexander the Great, whose transcendant genius embraced the whole domain of human science, prosecuted this, as well as every other branch of the history of nature, with an ardour and perseverance that have rarely been equalled, and never surpassed. Gifted with a mind of extraordinary acuteness and comprehension, he appears to have concentrated within it all the learning of his age, which, moulded and transformed by the power of his genius, assumed new forms of arrangement, yielded new products of generalization, and spread its luminous irradiation over every department of human knowledge. At the request of his pupil he undertook an extensive treatise on the natural history of animals; he was liberally furnished with specimens of all kinds, and empowered to command the services of numerous assistants, from every part of the vast empire of Alexander. He spared no labour in the prosecution of this undertaking, and in making the most profitable use of the resources thus placed at his disposal; and contributed in no small degree to the advancement of our knowledge of the animal economy in the diversified forms of life presented by nature. Yet with all the advantages he possessed, it would appear that his knowledge of human anatomy was exceedingly imperfect. He even acknowledges that the internal parts of the human body are but little known; and points out the probable advantages that might result from the examination of animals which have the nearest resemblance to the human species, for supplying these deficiences. But his work on the history of animals, περὶ ζωων ἱστοριας, is unrivalled by the magnitude of the field which it embraces, and by the vast information it contains. To him belongs the merit of arranging the facts in the order, not of their zoological, but their physiological relations; referring every organ to the functions it performs in the animal economy, and thus anticipating the very principle on which, in recent times, Hunter, Blumenbach and Cuvier have founded their more rational and philosophical views of comparative physiology.

The Ptolemies.

(1132.) The encouragement given by the Ptolemies, the successors of Alexander in Egypt, to every kind of learning, tended greatly to the advancement of anatomy and physiology. Permission was granted by these monarchs to dissect the human body, which none would otherwise have dared to attempt, in opposition to the prejudices of the Egyptians, which were no less violent against dissection than those of the Greeks.

Erasistratus.

(1133.) One of the earliest of the physiologists of this period was Erasistratus, the grandson of Aristotle, and the pupil of Chrysippus. Under the patronage of Nicanor, king of Sicily, he enjoyed frequent permission to dissect the bodies of those who were executed, and is even reported by *Celsus* to have had criminals delivered to him for the purpose of their being opened while alive, in order that the natural living state of the internal organs might be examined. This account, however, deserves to be regarded rather as a popular tale, which has no other foundation than irrational prejudices against dissection, and was propagated by idle credulity, and a passion for exaggerated scenes of horror. The works of Erasistratus are now lost; but from the quotations of later authors, he appears to have greatly advanced the knowledge of the structure of the human body, more especially by pointing out the circumstances in which it differs from that of other animals, whose anatomy had been previously studied as making the nearest approach to the organization of man.

Herophilus.

(1134.) Another no less distinguished anatomist of the same period was Herophilus of Chalcedon, who also flourished at Alexandria. He was the disciple of Praxagoras, and was considered as the founder of the medical school at Alexandria. He was much occupied in the dissection of human bodies, and directed his attention particularly to the nervous system. One of the sinuses of the brain, which he is said to have more particularly described, bears to this day the name of the *torcular of Herophilus*. He is stated to have been the first anatomist who taught osteology from the human skeleton. He distinguished the nerves from tendons and ligaments, with which they had, before his time, been confounded. He also paid minute attention to the varieties of the pulse, and thus laid a foundation for a knowledge of the important function of the circulation.

(1135.) Few physiologists of any note are recorded as having flourished from the time of Herophilus to that of Galen. The names of Lycus of Macedonia; of Marinus, who lived in the reign of Nero, have been transmitted to us as the author of some elaborate treatises on the muscles; and also of Rufus Ephesius, who wrote a work entitled *Onomasia*, which was considered as the best system of anatomical knowledge extant at that period.

Galen.

(1136.) Galen, the most celebrated and indeed the last of the physiologists of Greece, was born at Pergamos, in Asia

Minor, about 131 years before the Christian era. His father was imbued with the love of letters, and was anxious that his son should receive the benefit of a learned education, which the early promise he gave of superior talents shewed that he was well qualified to turn to advantage. He was placed under the tuition of the best philosophers of the time, and studied in all the schools with extraordinary diligence. His father died long before he could form any probable anticipation of the future fame of his son. It was two years after this event, that young Galen, who was now in his nineteenth year, first turned his attention to medical pursuits, of which he soon became passionately fond. As Alexandria was still the most celebrated school of medicine in the world, he travelled thither with a view of prosecuting his studies; in order to reap every advantage which foreign countries could afford, he visited in succession different parts of Asia Minor and the islands in the Ægean Sea. Anatomy was ever his favourite pursuit; but being debarred from the advantage of examining human bodies, the dissection of which had then been prohibited, even at Alexandria, he had recourse to that of such animals as were supposed to have the greatest resemblance in their structure to man. He has written very fully on every part of anatomy; so that his works may be considered as a system, exhibiting every thing which was known on the subject in his time. He was much impressed with the importance of anatomy as the basis of medicine and surgery, and enforces his opinion with singular acuteness and energy. This is evinced by the following passage in his second book of Academical Administrations:

"What can be more useful in wounds which are received in battle, in the extraction of darts, excision of bones, the reduction of luxations, the opening of fistulæ, than to be well acquainted with the anatomy of the limbs? It is of more use to be acquainted with the exterior than the interior parts of the body, as the shoulders, back, breast, the ribs, the belly, and the outward covering of the neck and head; for we are often required to cut into abscesses and sinuses. In the excision of bones it is necessary to cut and dissect; and if we do not know where the artery, vein, or nerve may be, we are more likely to be the cause of death than of health to the patient."

(1137.) Galen is entitled to great praise for having applied himself to the investigation of physiology in connexion with anatomy; so little had hitherto been known on this subject, that we cannot be surprised at the mixture of error which his works exhibit; but although he may often have proceeded on false principles and fallacious hypotheses, yet the reasonings themselves which he employs are always clear and conclusive. His account of the uses of the hand, for example, is remarkably perspicuous and correct. He succeeded in establishing by experiment the fact that arteries contain blood, and thus refuted the doctrines of the Alexandrian school that they are merely filled with air, which they serve to distribute throughout the body. It is interesting also to trace the effect which these subjects of contemplation produced on Galen's mind. After reviewing the structure of the hand and foot, and their adaptation to their respective functions, he breaks out into the following apostrophe, admirably characteristic of a mind imbued with the genuine spirt of piety:

"I esteem myself as composing a solemn hymn to the author of our bodily frame, and in this I think there is more true piety than in sacrificing to him hecatombs of oxen, or burnt-offerings of the most costly perfumes; for I first endeavour to know him myself, and afterwards to shew him to others, to inform them how great is his wisdom, his virtue, his goodness."

Dark ages.

(1138.) The great reputation which Galen had acquired, instead of promoting, tended rather to impede the progress of anatomy and physiology during several succeeding centuries. Where no hope was entertained of emulating the fame of one who was regarded as an infallible oracle, all motive to exertion was repressed. But other causes of a political nature also contributed to the decline of anatomy, as well as of other branches of learning, from the time of Galen to the downfall of the Roman empire, and during the ages of intellectual darkness which followed. Learning, however, still continued to be cultivated at Alexandria, until the capture of that city by the Saracens, in the year 640, when its magnificent library was burnt.

The Arabians.

(1139.) Anatomy and physiology began slowly to revive among the Arabians; but no addition seems to have been made by them to the knowledge which the Greeks had possessed on these subjects. The Arabian physicians were satisfied with what Galen had taught them; and as the rites of the Mahometan religion prohibited all contact with a dead body, an effectual bar was opposed to all improvement in anatomical or physiological knowledge. The work of Avicenna on anatomy is merely a compilation from Galen and other Greek authors; and whenever he ventures to differ from his authorities he is generally wrong. For more than a thousand years after the time of Galen, anatomical and physiological science may be considered as nearly stationary; for scarcely any discovery of the least importance was made during the whole of that period.

Avicenna.

Mundinus.

(1140.) The expeditions of the crusaders were the means of introducing into Europe some knowledge of the literature of the Arabians; and the light of science, after a long period of darkness and ignorance, began at length to dawn. In the fourteenth century, anatomy was revived by Mundinus, a Milanese, who had become acquainted with the writings of Galen through an Arabian translation, and who published a system of anatomy in 1315.

The fifteenth century.

(1141.) The destruction of the Greek empire by the Turks, in the succeeding century, tended to diffuse throughout the west of Europe, whatever portion had remained of the literature of the east. The learned of every profession fled from Constantinople, which had fallen into the hands of barbarians, and sought an asylum in Italy, where they disseminated the seeds of knowledge. The writings of Galen and of the ancients, could now be read in the original; their superiority to the Arabian authors was soon discovered; and such implicit deference was paid to their opinions, that for many ages no one would venture upon the slightest innovation. The improvement of anatomy was therefore exceedingly slow. It was promoted, however, by the exertions of eminent painters, such as Raphael, Albert Durer, Titian, and above all, Leonardo da Vinci, whose drawings evince considerable knowledge in that study.

The sixteenth century.

(1142.) The sixteenth century was more auspicious to the progress of anatomy, which was beginning to be cultivated with ardour in Germany and France, as well as in Italy. Berengarius of Carpi, professor at Bononia, acquired such reputation by his skill in dissection, that he was regarded as the restorer of this science. The structure of the ligaments and bones was successfully studied by Charles Stephens; that of the blood-vessels by Fernelius; and that of the muscles by Andernach. Sylvius was also at this time celebrated as a teacher of anatomy.

Vesalius.

(1143.) But the extravagant veneration of antiquity, that spell which has for so many ages held the medical world in thraldom, was at length broken by Vesalius, who boldly ventured to call in question the authority of Galen. This extraordinary man was born at Brussels in 1514, of a family which had for a long time cultivated medicine. He united to remarkable talents, a degree of ardour and perseverance which enabled him to overcome every difficulty; and his progress in the study of anatomy, for which he had very early shewn a partiality, was commensurate with these great qualities. He commenced his studies at Louvain, and prosecuted them in Italy. In a short time he made himself master of the Hebrew, Greek, and Arabic languages; so that before he had attained his twentieth year, he had already read the works of Galen and Avicenna in the original. Such was his zeal for anatomy, that it is reported he used to rob the gibbets, and dissect the bodies in his bedchamber. In a few years he excelled his teachers, Fernelius and Sylvius, who were esteemed the first anatomists of their time. He soon detected many errors in Galen, some of whose descriptions of parts had been taken from quadrupeds, and applied to man. These errors he ventured to disclose and to correct in his publications; but his boldness in appealing to nature from the authority of Galen, drew upon him the enmity of all the admirers of that great master. He was assailed from all quarters with the bitterest invectives; and Sylvius himself has not scrupled, in the heat of controversy, to brand him with the epithet of *Vesanus*, or madman, in allusion to his real name. The criticism which Vesalius had passed on Galen, was retorted by his enemies upon himself; and it must be confessed that in the plates which Vesalius published, some errors of the same kind were detected. But still their general accuracy was undeniable. The work of Vesalius was soon acknowledged to be unrivalled, and its author eventually enjoyed a complete triumph over all his opponents.

His fame reached the ears of Charles V., who appointed him his physician; but after being raised to that distinguished station, he was soon doomed to experience the inconstancy of fortune. Having obtained permission to examine the body of a Spanish gentleman, whom he had attended in his last illness, he began to lay open the chest, when the bystanders imagined they perceived a tremulous motion of the heart. This circumstance soon got wind, and probably with much exaggeration, reached the ears of the relations of the deceased, who, seized with horror, denounced Vesalius as a murderer; and coupling this charge with that of impiety, arraigned him at the tribunal of the Inquisition. Where superiority of knowledge was esteemed a crime, Vesalius, however unjustly he might be accused, was certain of condemnation. By the influence, however, of Philip II., who had then succeeded to his father Charles V., Vesalius was permitted to commute his punishment to a pilgrimage to the Holy Land, the merit of which, it was thought, might sufficiently atone for the heinousness of any crime. This journey he was accordingly obliged to perform; and on his return he was invited by the senate of Venice to teach anatomy, but he perished by shipwreck before he reached that city, when he was about fifty years of age.

(1144.) The impulse which had been given by Vesalius to the progress of anatomy, continued to operate; and many were the inquirers who pressed forward in the path in which he had so nobly led the way. The barriers to investigation had been removed; nature was open to inquiry; and men had only to observe and to think for themselves. Every year was now adding some new discovery; and it becomes no longer easy to trace the order of their succession, or to ascribe each to their proper authors. We shall endeavour, however, briefly to enumerate those which are most worthy of being noted.

allopius.

ustachius

(1145.) In the year 1561, Fallopius published, in Italy, his *Observationes Anatomicæ*, a work of much merit, and the fruit of great industry. About the same period also, Eustachius arrived at great eminence as an anatomist, and published a set of plates, which he himself engraved; their beauty and accuracy excite astonishment even in the present day.

abricius.

(1146.) *Fabricius ab Aquapendente*, a professor of anatomy at Padua, was also one of the most distinguished anatomists and physiologists of that period. He published a splendid volume on the formation of the fœtus, and bestowed much pains in investigating the mechanism of the motions of animals. He was the first who delineated and drew the attention of the public to the valves of the veins, which had, indeed, been imperfectly seen by Stephens, Sylvius, and Vesalius, and the existence of which had been denied by Fallopius and Eustachius. It was this discovery, perhaps, more than any other, which paved the way for that of the real course of the blood in its circulation; a discovery which was reserved for the illustrious *Harvey;* and which has justly rendered his name immortal. As it may be interesting to review the steps which led to this important physiological discovery, we shall retrace its history to a period somewhat more remote.

Discovery of the circulation.

(1147.) It is perfectly well ascertained, from an examination of the works of Galen, and of others who have copied from him, that the ancients had not the most distant notion of the real nature of the circulation. The blood was believed by them to have its origin in the liver, and to be undulated alternately in opposite directions in the veins; they imagined that the finer part of it transuded through the septum, or partition separating the cavities of the heart, from the right to the left side, where it mingled with the air received into the lungs, and forming a vital spirit, was moved by a sort of flux and reflux along the arteries.

Cœsalpinus

(1148.) On the revival of anatomy in Europe some vague notions of the pulmonary circulation appear to have suggested themselves to many eminent men. Vesalius demonstrated that the blood could not possibly pass from the right to the left ventricle through the septum of the heart. Realdus Columbus, who was professor of anatomy at Padua, and had been a pupil of Vesalius, distinctly traced the passage of the blood through the vessels of the lungs. The same fact had, however, been already discovered by Michael Servetus, who was born in Aragon in 1509, and who is more celebrated as a theologian than as a physiologist. Further progress was made by Andrew Cœsalpinus, an Italian physician, who speaks of a communication existing between the veins and arteries at their remote extremities, and notices the effect of the valves of the arteries and of the auricles as calculated to prevent a reflux of the blood; but he is quite at a loss to reconcile this observation with the common notions, which he had imbibed, and to which he still adhered, of the functions of these vessels. But notwithstanding these apparent approximations to the truth, it is probable that many ages would have elapsed before the complete discovery of the circulation, if some bold and penetrating genius, such as that of Harvey, had not arisen.

Harvey.

(1149.) This illustrious man was born in the year 1578; and the circumstances of his family gave him the advantage of a liberal education. After six years spent at Cambridge, where he was instructed in all the philosophy of the times; finding that the university furnished but very imperfect means of studying either anatomy or medicine, he repaired, at the age of twenty-one, to Padua. Here he became the pupil of Fabricius, who was at the time demonstrating to his students, with all the enthusiasm of a discoverer, the newly observed valvular structure of the veins. The attention of Harvey being thus directed to this remarkable conformation, he became anxious, on his return to England, to prosecute the inquiry into the purposes which were accomplished by it. He was obliged, for this purpose, to make many experiments on living animals; and these revealed to him the real course of the blood in its circulation; a discovery which ranks unquestionably as the noblest and most important ever made in Physiology. Harvey taught this new doctrine in his lectures about the year 1616; but did not publish any account of it till the year 1628. On its being made known to the world, it met with the most violent opposition; and so inveterate were the prejudices of the public, that the practice of Harvey was considerably diminished in consequence of his discovery. It was remarked that no physician who had passed the age of forty would admit the truth of a doctrine so much at variance with all the systems in which he had been educated. Envious of his growing reputation, many of his cotemporaries had recourse to all kinds of sophistry with the view of detracting from his merit. They at first vehemently contested the truth of the doctrine; but afterwards, when forced to admit it by the decisive evidence adduced in its support, they changed their ground of attack, and alleged that the merit of the discovery did not belong to Harvey, the circulation having been known even to the ancients. But vain were all the efforts of envy and detraction to lessen that fame, which will command the admiration of all future ages. The physiological researches of Harvey were not confined to the function of circulation; but extended also to that of generation, and to the evolution of the ovum, on which he made a series of very valuable observations.

Asselli.

(1150.) The beginning of the seventeenth century was an important era in anatomy, for it was also marked by another brilliant discovery, namely, that of the lacteals by Asselli in 1622. It appears, from the testimony of Galen, that Erasistratus had noticed white vessels on the mesentery of kids; but the observation was not followed up, and these vessels were supposed to have been merely veins. Asselli was born at Cremona, and was professor of medicine at Pavia. He observed on the mesentery of a dog numerous vessels, filled with a white fluid; he was immediately convinced that he had made an important discovery, and uttered in the fullness of his feelings, the exclamation "Ευρηκα." Perceiving similar vessels upon the surface of the liver, and entertaining some theoretical views concerning the functions of that organ, he too hastily concluded that the lacteals terminated in the liver. Asselli published an account of his discovery with coloured prints in 1627.

Pecquet.

(1151.) It was not till about thirty years after this discovery of Asselli, that the lacteals were traced by *Pecquet*, a French anatomist, into the receptaculum chyli, and thence into the thoracic duct, which he also followed to its termination in the great veins near the heart. These observations were published in the year 1651. All these discoveries were made in brutes; and it remained to be shewn, that similar structures existed in man. This was accomplished by Veslingius, who had already demonstrated the human lacteal vessels, in the year 1634; and the human thoracic duct in 1649. These parts were afterwards more fully investigated by Peirish and Vanhorne. Shortly afterwards, the general absorbents of the body were discovered by Olaus Rudbeck, a Swede, who was born at Avosa, in the year 1630. This discovery was also claimed by Thomas Bartholin, who was born at Copenhagen in the year 1616; but by his own account he had not seen these lymphatic vessels till December 1651, whilst Rudbeck had not only observed them, but had distinguished their peculiarities the year before; Rudbeck had also traced them to the thoracic duct, which Bartholin had failed to do. Dr. Joliffe, an English physician, has also contended for the honour of this discovery; but from a comparison of dates, the priority is clearly in favour of the Swedish anatomist. When we consider the minuteness of these vessels and the transparency of their coats, we are able to appreciate the difficulty of detecting their existence, and our surprise must cease at their having remained unknown for so many ages.

Rudbeck.
Bartholin.

(1152.) No discovery of equal importance to those we have mentioned has been made in anatomy since that period. Many parts of the body, which were unknown in Harvey's time, have indeed been brought to light; but the principal improvement has consisted in a more accurate knowledge of the composition and minute structure of the several organs. For this we are chiefly indebted to the invention of new anatomical processes both of investigation and of demonstration. Two principal means were employed in these researches; the one was the microscope, the other the practice of injections.

Malpighi.

(1153.) The microscope was first applied to the purposes of anatomical inquiry about the year 1661, by Malpighi, who was born near Bologna, in the year 1638. He examined, by the aid of this instrument, the minute organization of all the vital parts; and more particularly the glands. These researches into the intimate texture of the various parts of animals were prosecuted with great ardour by Leeuwenhock, a Dutch anatomist, about the year 1680. In exploring this new field of inquiry, which opened views so remote from common apprehension, his enthusiasm has often carried him beyond what was real, both in the power of the instrument, and in the results it afforded. But still much has been effected, and the boundaries of the science have been greatly enlarged by the skilful employment of the microscope.

Leeuwenhoek.

Vanhorne.

(1154.) The arts of preserving the parts of animals when dissected, by drying and varnishing them, and by other modes of preparation, had long been practised; and in these Vanhorne is said to have attained superior excellence. But the most valuable invention of this kind was that of injecting into the vessels certain fluids which would, after a time, become solid, and admit of the course of these vessels being easily traced. The injecting syringe used for this purpose was invented by De Graaf, a Dutch anatomist, about the middle of the seventeenth century; and soon after, the proper materials for injection were discovered by Swammerdam. The art of injection was carried to a very high degree of perfection by Ruysch; but with a degree of selfish illiberality which cannot be too strongly condemned, he kept secret the methods he employed.

De Graaf
Swammerdam.
Ruysch.

(1155.) The advancement of Physiology was greatly promoted both by the practice of this art, and by the dexterous employment of the microscope; and discoveries in this science have succeeded one another so rapidly from the period of their invention, that in giving an account of them, it is scarcely possible to preserve an unbroken narration; and it would be impossible, in this sketch, to recount the numerous minor improvements which have been made in our knowledge of this department of science from the epoch down to which we have now brought its history. Much error was still mingled with the acquisition of real knowledge on these subjects; and it has required the exertion of the more severe and scrutinizing spirit of inquiry which characterizes the philosophers of a later period, to winnow the grain from the chaff, and refine the pure metal from the superfluous ore which had been dug up along with it from the mine. Physiologists were slow in recognising the peculiarities which appertain to the vital powers, and those of the beginning of the eighteenth century long persisted in ascribing the phenomena of life to the operation of the same laws which regulate those of inanimate nature. Hence the history of physiology is occupied at that period, chiefly by the contentions which arose between the rival sects of chemists and mathematicians; each striving to apply to physiology the principles and methods of investigation which prevailed in their respective sciences. Much ingenuity was wasted in these unprofitable researches; for although some important fact was occasionally brought to light by the prosecution of elaborate inquiries, prompted by endeavours to support each favourite speculation, yet not one of these hypotheses could long maintain its ground, nor could it be said that a single general principle had been established.

(1156.) A new light was now thrown on the subject of physiology, which tended to dissipate the clouds of error in which it had been obscured by the dogmatical tenets of both the chemical and the mechanical sects; and to effect a complete renovation in the science. The new doctrine which thus superseded the former, originated in Stahl; who, although educated in the school of the chemists, soon shook off the trammels of his instructors, and with the vigour of

Stahl,
Hoffman,
and Boerhaave.

native genius began to reflect for himself. He perceived the futility of their doctrines, and strongly impressed with the wide differences observable between the phenomena presented by organized beings, and those which the same bodies exhibit when devoid of vitality, conceived that they were governed by some agency opposed to the ordinary physical powers of matter; and to this agent he gave the name of *anima*, (see §. 101), ascribing to it endowments allied to intelligence, which controlled all the changes in the system, and of which the operations were always directed to salutary ends. This hypothesis, gratuitous and unphilosophical as it was, had the beneficial effect of directing the attention of physiologists to the phenomena which peculiarly characterise the living state, and prepared them for the study of the laws of these vital phenomena. Much praise is also due to Hoffmann, who, although too hasty in his conclusions to inspire confidence in their correctness, appears to have been amongst the earliest of the followers of Stahl, who entertained proper views of the principles and objects of physiology. Boerhaave was celebrated at this time for the extent of his information, the soundness of his judgment, and his talent in the art of instruction. His doctrines had extensive influence in the schools of medicine; but being destitute of the solid support of facts, they did not long survive their propounder.

Haller.

(1157.) But the great founder of modern physiology is unquestionably Haller, whose labours in this field of inquiry are so prodigious in extent, and so fruitful in results, that the publication of his Elements, to which it may be perceived we have had occasion in the course of this treatise perpetually to refer, must be considered as forming an important era in the history of the science.

Whytt, Cullen, Hunter, Bichat, &c.

(1158.) The attention of physiologists was beginning to be more particularly directed to the functions of the nervous system; and the labours of Whytt at this period had tended much to give it this impulse. Amongst the host of names which claim our notice as having contributed their share in the rapid progress of discovery, since this time, we can point out only a few of the most illustrious. William Hunter, the Monros, and Cullen, are amongst those most eminent for the services which they have rendered to physiology; but perhaps the largest contributor to the mass of facts collected in modern times was John Hunter. The merits of Bichat were also of the first order; and considering how early his career was cut short by the hand of death, the additions which he has made to the stock of facts, and the influence which his opinions have had on the progress of the science, must excite astonishment. Germany and Italy, as well as France, have been prolific in ardent devotees and successful cultivators of physiology; and although it might be invidious to point out particular names, we should be sorry to omit those of Spallanzani, Blumenbach, Soemmerring, Meckel, Gmelin, and Müller; nor should the justly earned fame of Cuvier be passed over in silence, even in this brief and imperfect retrospect of the benefactors of our race, for such we must esteem all those who enlarge the sphere of human knowledge, and thereby confer the most solid accession to the power and happiness of man.

(Y.)

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PHYTOLOGY, a discourse concerning the growth, the kind, and the virtues of plants.

PIALAPORE, a town of Bengal, in the district of Dacca, famous for its manufactures of earthenware. Long. 90. 8. E. Lat. 23. 35. N.

PIALNY, a town of the south of India, in the district of Dindigul. Long. 77. 37. E. Lat. 10. 28. N.

PIA Mater, a thin membrane which covers the brain, and is in immediate contact with it. See Anatomy.

PIACENZA. See Piazenza.

PIANO-FORTE, a well-known modern instrument, in which the immediate sonorous bodies are wires of brass and steel. It has completely usurped the place of the old harpsichord, upon which it is a great improvement. Of late it has undergone many modifications, which are too numerous to be noticed here. The merit of its invention is disputed by the Italians and the Germans. Count G. R. Carli, in his works printed at Milan in 1784–1794, states (in vol. xiv. p. 405), that the piano-forte was invented in 1718, by Bartolommeo Cristofori of Padua, during his stay in Florence. The count speaks indignantly of the forgetfulness of the Italians regarding their own inventions: "Della quale inventione ci siamo scordati a segno, che l'abbiam creduta una nuova cosa, allorchè ci venne dalla Germania e dall' Inghilterra, accogliendola come una singolare produzione di quelle felici regioni, destinate ad illuminarci con i lumi presi dagl' Italiani." On the other hand, the Germans assert that it was invented about the year 1717, by C. A. Schrœter, a German organist, and that it was afterwards improved by Silbermann, G. A. Stein, and others. The English makers have, of late years, gained great repute by their excellent piano-fortes. Amongst the best may be mentioned those made by the Broadwoods, and by Clementi, Erard, and Collard. Those of Broadwood are distinguished by a rich soft tone, well suited for accompanying the voice. Erard's possess a more powerful and brilliant tone, and are better suited for the public performer of piano-forte sonatas, concertos, &c. The horizontal piano-fortes are those most used, as being the best. The origin of the vertical piano-forte may be found in Père Mersenne's *Harmonicorum libri xii.* 1652, folio; in which there is an engraving of a similarly formed instrument of an ancient date. We consider the modern extreme extension of the compass of the piano-forte, both grave and acute, as detrimental to the best effects of the instrument. On this subject, and as to the true powers of the piano-forte, see the article Music, vol. xv. pp. 644, 645. An Italian writer informs us, that in the beginning of the present century he had played upon many piano-fortes of a compass of *six octaves and a half*, made by Antonio Gherardi of Parma.

PIAS, or Bias, a town of Asiatic Turkey, supposed to be the site of the ancient Issus, near which was fought the celebrated battle that decided the fate of the Persian empire. Not many years since it was the residence of a powerful and warlike chief, who rebelled against the grand signior, plundered caravans, and laid the neighbouring countries under contribution. The Turkish ruler, provoked by these outrages, fitted out a fleet, which took the town of Pias, and reduced it to a heap of ruins.

PIASANSKOI, Verschnei, a village of Asiatic Russia, in the government of Tobolsk, near the Frozen Sea. There is another village of the same name, twenty-eight miles to the north of it, and four hundred and sixty miles north of Turuchansk.

PIASTUS, a native of Poland, was originally a wheelwright, and the son of Cossisco, a citizen of Cruswitz. He flourished in the year 830, when, on the extinction of the family of Popiel, great disputes arose about his successor, and Cracow was afflicted with a severe famine. During this extremity, when the people were dying in the streets, the credulous historians of the time relate that two pilgrims, or two angels in human form, having been hospitably entertained by Piastus, they promised him the crown of Poland; and being ordered by the pilgrims to distribute among the multitude his only remaining little cask of the common liquor of the country, he piously obeyed their instructions, and the cask was found inexhaustible. The people in astonishment cried out, "a miracle;" and as it appeared to the electors that this was a declaration of Heaven in favour of Piastus, they resolved on elevating him to the vacant throne.

Though we make but little account of the marvellous means by which it is said that the hospitable wheelwright ascended the ducal throne of Poland, it would be presumptuous entirely to omit a fact attested by all the writers upon this subject. It seemed proper therefore to take notice of it, but we leave it to the reader's judgment to attach what faith he pleases, or none at all, to the story. Being now raised to the supreme dignity, he was not intoxicated with his prosperity. His natural charity, benevolence, and sweetness of disposition, remained; nothing being altered but his power of doing good. He was truly called the father of his people; the injured never returned unredressed, nor merit unrewarded. Piastus wiped the tear from the eyes of the widow; and was himself the guardian of the orphan, the general patron of the poor and distressed. His excellent inclinations served him instead of great abilities; and the happiness which his people enjoyed made them forget that their prince was not born a statesman and a warrior. Several intestine commotions arose during his administration, all which he quelled by the mildness and clemency of his nature; for his nobility were ashamed of rebelling against a sovereign who devoted his whole life to render his people happy. He removed the court from Cruswitz, a city which he detested, because it was the scene of Popiel's crimes and tragical end, and fixed his residence at Gnesna, where he died beloved, esteemed, and even adored, by his subjects. It is in memory of this excellent prince that all the natives of Poland who have since been promoted to the ducal or regal dignity were called Piastes, in contradistinction to the foreigners.

PIATNITZKA, a village of Asiatic Russia, in the government of Tobolsk, twenty-eight miles north-north-west of Eniseisk.

PIAUHY, a large province of Brazil, is bounded on the east by the Serra Hibiappaba, which separates it from the province of Seara; on the south by the Serra of Piauhy, which separates it from Pernambuco; on the north by the Atlantic Ocean; and on the west it is separated from Maranham by the river Parnahiba. Although classed amongst the inland provinces, it has about eighteen leagues of coast, its form being almost triangular, whilst on the southern side, where it borders on Pernambuco and Goyaz, it expands to upwards of one hundred leagues in width. It stretches from the Atlantic Ocean inland, that is, from north to south, about one hundred and twenty leagues; so that if we estimate its average breadth at fifty leagues, its area will be equal to that of England and Wales. Originally it formed a comarca of Maranham; but in the year 1718 it was erected into a separate province, although it did not receive resident governors until forty years after that period. Originally Piauhy was explored and subdued on account its pastures, and not for the sake of slaves or from its possessing mines of the precious minerals or metals, for in these it appears to be deficient. Domingos Affonso, its conqueror, was the most extensive grazier in Pernambuco, and at his death bequeathed thirty of his large fazendas to the Jesuits, in trust for specified objects of charity; but on the expulsion of the order the trust fell into the hands of the crown. These estates, with three others added by the Jesuits, continue to be administered by government for the purpose intended by the original donor. The number of fazendas in the province is very great; as early as the year 1724 they amounted to no less than four hundred. It is to Piauhy that the neighbouring provinces of Pernambuco, Maranham, Bahia, and Minas Geraes look chiefly for their supply of cattle. A flourishing fazenda produces annually nearly one thousand calves; but after deductions for tithes and herdsmen, it is only able to export from two hundred and fifty to three hundred oxen. The cows are always reserved for breeding and home consumption; the rest are accounted for by the plague of flies, vampire-bats (from which the folds afford no security), jaguars, snakes, poisonous herbs (of which there are many kinds), and, above all, by drought, which frequently converts all the grass in the country into standing hay; and when that is consumed, the cattle perish by thousands.

Piauhy occasionally suffers greatly from drought, but the evils consequent thereupon are much ameliorated by the presence of several trees which yield abundance of grateful and wholesome juices. Travellers have sometimes owed their lives to the *imbuzeiro*, a remarkable tree, which is found in the most arid regions of Brazil. "Bulbs," says Southey, "about a palm in diameter, and full of water, are attached to its shallow roots. Arruda names this tree *spondia tuberosa*. Its fruit is smaller than a hen's egg, and, under a tough skin, contains a succulent pulp of a grateful flavour, at once acid and sweet. The Brazilians make a dainty of its juice with curds and sugar. The people of Piauhy make a beverage from the *buriti*, one of the loftiest and most beautiful of the palm tribe, but which grows only in moist or swampy places. Its fruit is about the size and shape of a hen's egg, covered with red scales arranged spirally; under these is an oily pulp of the same vermilion colour. The liquor which they prepare from it is said to be nutritious and palatable; but if drunk in excess it has the singular property of tinging the skin and the white of the eyes, without appearing to affect the general health." Another tree of great importance to a country like Piauhy, where drought is the great evil, is the *piqui*, which prospers in a dry and sandy soil, and produces abundantly a wholesome oily fruit, the size of an orange, to which the inhabitants are very partial. It grows to the height of fifty feet, having a proportional girth; and the timber is useful for ship-building. Some parts of the country have been redeemed from a desert state by tanks being formed on the rivers which dry up in summer. By thus laying in a store of water during the season when the streams are at the fullest, the herdsmen were enabled to establish fazendas, where otherwise it would have been certain destruction to the cattle to allow them to range.

The capital of this province, which, till the year 1762, bore the name of Mocha, received from king Joze, along with the title of city, the appellation of Oeyras, in honour of the great minister, the first count of that name. It is situated on a small stream, which, three miles lower down, falls into the Caninde, a confluent of the great Parnahiba, with which it unites twenty miles below. The town is small, and only remarkable from its being the capital of the province. It contains a church and two chapels; and the houses, although not numerous, are said to be commodiously and even elegantly constructed. The greater part of the inhabitants are Europeans, and, including the surrounding district, amount to fourteen or fifteen thousand.

A larger and much more important town than the capital, is St Joam da Barra da Parnahiba, situated seventy-five leagues north of Oeyras. It is built on sandy ground, five leagues from the sea, on the right bank of the eastern and largest branch of the river from which it takes its name. This is the seaport of the province, but the river, although navigable for barks of considerable tonnage more than a hundred leagues up, has diminished in depth so much near its embouchure, that vessels which used to ascend to the town are now under the necessity of mooring two leagues below it. The entrance is besides rendered dangerous by shoals and a heavy surf. Parnahiba contains some houses of one story above the ground floor, which are not seen in any other town in the province. This place is badly supplied with water, and fevers prevail to some extent; but its advantageous position on the great stream which traverses the western limits of the province, as well as its being the only seaport, secures it a considerable trade, and it is a great dépôt for cotton and hides. The surrounding country produces also excellent melons, and the tobacco raised in the south-western part of the province is preferred even to that of Bahia. There are several other towns, the principal of which is Piracuruca, situated on a river of the same name, and lying on the line of road from Villa Vicoza to Pernambuco. It carries on a considerable trade in cotton, and mandioc is cultivated to some extent. The river Piauhy, from which the province derives its name, originates in the southern frontier, and, running northward through pasture lands, enters the Caninde fifty miles below the capital, after a course of 140 miles. There are no serras of any consequence, nor any large forests, in this province. It consists, indeed, of vast grassy plains, little wooded, but in which numerous tall herbs attest the bounty of the sun. The population may be estimated at 50,000. (R. R. R.)

PIAZENZA, Placentia, or Plaisance, one of the four districts composing the duchy of Parma, in Italy, and which contains ten cantons. The capital is the city of the same name. It stands on the right bank of the Po, about a furlong from the stream. It is the see of a bishop, is situated in a rich and beautiful district, is surrounded by walls, which are rather adapted for promenades than for defence, and has a citadel, garrisoned by Austrian troops. The streets are straight and long, especially the one called the Stradone, which is very magnificent. The cathedral is a fine specimen of Gothic architecture, and has a gilded cupola. The city contains 2000 houses, two hundred of which are called palaces, and 16,500 inhabitants, whose chief occupation consists in preparing silk and weaving it, and trading in wine, oil, and cheese. Long. 9. 37. 12. E. Lat. 45. 2. 4. N.

PIAZIDA, a river of Asiatic Russia, which rises in the government of Tomsk, and falls into the Frozen Ocean after a course of 300 miles. Long. 87. 14. E. Lat. 73. 30. N.

PIAZINSKOI, a lake of Asiatic Russia, in the government of Tobolsk, 252 miles north of Turuchansk.

PIAZZA, a town of the island of Sicily, in the intendancy of Calatanisetta and district of Noto. It is a fine town, situated on a hill, in a healthy situation, 100 miles from Palermo, the Plutia of Diodorus. It contains 2424 houses, with 13,000 inhabitants, who cultivate the fertile soil near them, and carry on a great trade in its production. Near to it is the Lake of Pergusa, the scene of the rape of Proserpine.

Piazza, in building, popularly called *piache*, an Italian name for a portico, or covered walk, supported by arches. The word literally signifies a broad open place or square; and hence it was also applied to the walks or porticoes around them.

PIBROCH, says Dr Beattie, in his Essay on Music, is a species of tune peculiar to the Highlands and Western Isles of Scotland. It is performed on a bagpipe, and differs totally from all other music. Its rhythm is so irregular, and its notes, especially in the quick movement, so mixed and huddled together, that a stranger finds it almost impossible to reconcile his ear to it, so as to perceive its modulation. Some of these pibrochs, being intended to represent a battle, begin with a grave motion resembling a march, then gradually quicken into the onset; run off with noisy confusion and turbulent rapidity, to imitate the conflict and pursuit; then swell into a few flourishes of triumphant joy; and perhaps close with the wild and slow wailings of a funeral procession.

PIC DE L'ETOILE, Le, a small island in the South Pacific Ocean, so named by M. Bougainville in 1768, from its shape. It is one of the group called by Cook the New Hebrides. Long. 169. E. Lat. 14. 29. S.

PICA, or Pye, had formerly the same sense as *ordinal*, meaning a table or directory, pointing out the order in which the devotional services appointed for different occasions were to be performed. Accordingly we are told it is derived from ϖι, a contraction of ϖιναξ, *a table;* and by others from *litera picata*, a great black letter at the beginning of some new order in the prayer. The term was used in a similar sense by officers of civil courts, who called their calendars or alphabetical catalogues, directing to the names and things contained in the rolls and records of their courts, the *pyes*.

Pica, or *Picus, John*, prince of Mirandola and Concordia, was born in the year 1463, under the pontificate of Pius II. He was the youngest son of John Francis of Mirandola, and Julia, a lady of the noble family of Boiardo. Some of the credulous historians of the time have related, that at his birth a globe of fire was seen to rest upon his mother's bed; portending, say they, by its shape the perfection of his genius, and by its element the celestial turn of his mind. As soon as he was capable of receiving instruction, he was placed by his mother's care under the most able masters, and very early distinguished himself by the vigour of his application, and the strength of his memory, of which such prodigies are related as would be very difficult to credit, were we not assured, by some modern instances, of the perfection to which that faculty may be carried. At the age of fourteen he was, by the direction of his mother, who was desirous that he should assume the clerical functions, sent to Bologna, at that time the principal resort of those who studied the pontifical law. After spending two years there, he became disgusted with this pursuit; although such was his industry, even at that early age, that he compiled an epitome of the pontifical epistles or decretals. His disposition, however, led him strongly to the pursuit of philosophy, and excited an eager curiosity to penetrate the secrets of nature and science. With this view he travelled over Italy and France, visited the most celebrated schools of each, and studied under the most famous teachers of both countries.

After seven years spent in this course of instruction, and at the age of twenty-three, he went to Rome, and, after the fashion of the scholars of that time, brought himself into notice by publicly proposing literary questions for disputation. This sort of challenge was very common in that age, and, when printing was scarcely practised, and the name of a man of learning less rapidly extended than it is now, was almost the only method that a person of superior attainments could adopt to make himself known. Mirandola proposed nine hundred questions, or, as they were called, *Conclusiones*, in dialectics, mathematics, natural philosophy, and divinity; drawn not only from the stores of the Latin and Greek, but from the mysteries of the Hebrews and the arcana of the Chaldeans and Arabians. In addition to the endless topics of metaphysics, theology, and the ordinary subjects of disputation, into which he entered very profoundly, the *Conclusiones* involved the ancient and obscure philosophy of Pythagoras, Trismegistus, and Orpheus; the doctrines of the Cabbala, or mystical interpretation of the sacred writings, according to the Hebrews, taught by Origen and Hilarius; and the extent, uses, and learning of natural magic, which was vindicated from the vulgar reproach of impiety and necromancy. Seventy-two new physical and metaphysical dogmas of the author's invention were likewise proposed and defended. These propositions, according to the ostentatious practice on these occasions, were fixed in the most public places in Rome; and the proposer engaged to defray the expenses of any one who should come from a distance for the purpose of disputing with him. This challenge did not bring forward any disputants, but exposed Mirandola to much envy and jealousy, particularly from the professors of science at Rome, who felt the reflection that would be thrown upon their credit by their declining a competition which they durst not encounter.

Unable to injure his fame as a scholar, they made a much more dangerous attack upon the soundness of his faith. Thirteen questions were selected, which were charged with the terrible suspicion of heresy, and contempt of the ordinances of the church; a suspicion very readily listened to by the church when directed against great learning, which the increasing influence of philosophy and letters began to make her watch with extreme jealousy. Mirandola repelled this attack by publishing his *Apologia*, or Defence of the accused propositions, which, if he did not effectually clear away the suspicions he had incurred, tended to confirm his enemies in their dread of his learning and powers; and it must be owned that, overlooking the misapplication of talents to such subjects, the *Apologia* exhibits a command of profound and well-digested learning and keen argument, truly astonishing at the age of twenty-three. This work, and the discussions it contained of certain delicate points, added to some hints of the limit of pontifical control in matters of faith, were so disagreeable to Pope Innocent VIII. that he interdicted the reading both of the Apology and the disputed questions. The love of glory, however, was not Mirandola's only passion. His youth, splendid accomplishments, and the graces of his person, for which he is said to have been remarkable, attracted the admiration and caresses of many distinguished Roman ladies, who united the love of letters to that of pleasure, a taste very common amongst the Italian ladies of that age. The young philosopher yielded to the force of these allurements, or rather, according to the account of his nephew and biographer, Francisco di Mirandola, eagerly followed the bent of his disposition, naturall y inclined to obey the attractions of beauty.

But this life of pleasure, however suitable to his condition and inclinations, was of a short continuance. Irritated by the restless persecutions of his enemies, and obliged perpetually to defend himself against the imputation of heresy, the most formidable calumny which in that age any man could have to contend with, he detached himself from vicious pleasures, and regulated his manner of life by rigidly observing the laws of abstinence imposed by Christianity; for being a firm adherent of the Christian doctrines, the charge of infidelity and the vigilance of his enemies made him the more solicitous to guard against the appearance of disobeying them. From this time becoming wholly devoted to learning, he soon acquired such celebrity that the most eminent scholars from all parts of Italy came to visit him for conversation or instruction. As a proof of the sincerity of his reformation, he committed to the flames five books of elegiac poetry which he had composed upon the subject of his amours, together with numerous pieces in Tuscan verse, which had been addressed to his various mistresses. There is perhaps reason to lament that the zeal of the new convert could not be satisfied without this sacrifice. It must, however, be considered that the spirit of religion at that period exacted many sacrifices from the professors of Christianity, which the lenient temper of these times does not call for. An example of this severity is to be met with amongst the works which still remain of Mirandola, and at the end of which, in the folio edition published by his nephew, we find a learned and entertaining comment, in the Italian language, upon a composition of his friend Girolamo Benivieni, entitled *Una Canzone de Amore secundo la mente et opinione de' Platonici*, a poetical treatise upon love, explaining the doctrines of the Platonists. The author, Girolamo, informs the reader, in a short preface, that he had determined to suppress this poem and comment, out of regard to his friend's character and his own, deeming it unbecoming a professor of Christianity, in treating of celestial and divine love, "to treat of it as a Platonist, and not as a Christian;" but that having lent it to some of his friends for their perusal, an imperfect and erroneous copy was printed, which obliged him, but not until after the death of Mirandola, to publish it correctly. He takes care to allege, in excuse of himself, however, that he has apprised the reader of his plan by the title of the poem, and warned him, in all places where Plato's opinions depart from those of Christ, that the doctrines of a Gentile and a heathen are not entitled to the least weight compared with the reasonings of the Christian theologists, "and particularly the irrefragable arguments of the angelic doctor St Thomas of Aquino."

The first fruit of Mirandola's devotion to sacred literature was the Heptaplus, or Comment upon the Six Days of the first chapter of Genesis, which was written in 1491. Two years afterwards he published a treatise in ten chapters, *De Ente et Uno;* the object of which was to reconcile the doctrines of Plato and Aristotle, and to demonstrate that the disputes of their respective followers originated in a misconception of the opinions of these philosophers relative to the *Ens* and the *Unum*, at that time a subject of mighty strife amongst the learned. This treatise was held in high estimation by both sides. It was the last work of consequence which the author lived to complete; but he had laid the plan of a vast and comprehensive work, of which his early death prevented the execution. This was no less than to confound the seven enemies of the Christian church, by examining and refuting all their errors. In the prosecution of this design, he had, before his death, composed and perfected twelve books against astrology, the most popular and the most pernicious superstition which then infested the world. Paulus Jovius, bishop of Nocera, has left a testimony to the merits of this work, which is above all other encomiums. "In this excellent though unfinished work, Mirandola attacked the astrologers with such erudition and keenness, and so ably exposed the absurdity and vanity of the whole art of divination, that he seems to have deterred the professors of the occult sciences from writing."[1]

This great design, as well as many others which Mirandola had formed, particularly that of a more complete essay towards reconciling the opinions of Plato and Aristotle, was frustrated by his death. From the time that he left Rome, which was soon after the publication of the *Apologia*, Mirandola generally resided either at Ferrara or at Florence. The friendship of the Prince of Ferrara, and its vicinity to his paternal seat, attracted him to the former place; but Florence was the most agreeable to him, on account of the society of literary men which it afforded, and particularly that of Politian and Lorenzo de' Medici, with whom he entertained a close friendship. Besides these two illustrious men, his society was cultivated by other eminent scholars, amongst whom was the learned and unfortunate Hieronymus Savanarola, and Hermolaus Barbarus. Petrus Crinitus, the pupil of Politian,[2] mentions him as excelling all his companions in the erudition and eloquence of his conversation. The same author has left us an account of Pica's laborious studies; for when Politian had expressed in his presence high admiration of his great genius and learning, Mirandola with singular modesty answered, that he deserved no praise except for his assiduous application: "Gratulandum potius, intelligite, assiduis vigiliis atque lucubrationibus, quam nostro ingenio plaudendum."[3]

His library is likewise celebrated by the same writer, and is said by Francisco di Mirandola to have cost seven thousand pieces of gold. His accomplishments were not confined to subjects of abstruse literature; in his youth he was much attached to music, in which he acquired such skill, that some of his melodies were publicly received, and held in great esteem. It might also be concluded, from an anecdote related by Petrus Crinitus, that he was not unacquainted with physic; for, according to that author, when Hermolaus Barbarus was seized at Rome with a dangerous fever, Mirandola sent him from Florence a medicine prepared by himself. No man ever testified a more sincere devotion for learning and philosophy, to the contempt of all other qualifications, than the Prince of Mirandola. He possessed a very large estate, which he bestowed almost entirely upon works of charity, except what was spent in collecting books, and entertaining and providing for literary men. At length, however, about three years before his death, he made over to his nephew Francisco his principality and possessions in Mirandola, and obtained a confirmation of the grant from Maximilian, the Roman emperor, to whom that principality was subject. He reserved to himself only enough to purchase a small estate near Ferrara, where he spent the remainder of his life, except when he resided at Florence, in elegant and learned retirement. His mother, under whose care he received his education, had destined him for the church; and he was often urged by his friends to embrace the sacred profession, with the certainty of the highest honours and emoluments; but nothing could induce him to quit the life which he had chosen for himself. He died of a fever, at Florence, in the year 1494, in the thirty-first year of his age, on the same day that Charles IX. of France entered the city on his famous expedition into Italy. That monarch, hearing of Mirandola's illness as he approached the city, sent two of his own physicians to his assistance; but, in spite of their aid, the violence of his disorder put an end to his existence in thirteen days.

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[1] Paulus Jovius, *Elog. Doct. Vir.* p. 92.

[2] P. Crinitus *De Honesta Disciplina*, lib. iii. c. 2, lib. v. c. 1, and lib. ii. c. 2.

[3] *Ibid.* lib. ii. c. 2.

With respect to the works of this author, something has already been said, and little more remains to be observed. The *Conclusiones* afford a very complete specimen of the learning of the age, and of what were deemed the most valuable purposes to which learning could be applied. However useless and unprofitable these purposes may appear to us, it will not be denied by any one who has the curiosity to look into the *Conclusiones*, that the mass of learning possessed by the proposer of them must have been prodigious, when it is recollected, that at the time he proposed them, he was no more than twenty-three years of age. For there is not the least reason to suppose, that a person whose works prove him to have been a man of profound learning, and who, in an age and nation distinguished by some of the brightest scholars that ever appeared, was ranked by their unanimous judgment amongst the first, should have challenged the discussion of any of the proposed subjects, without being well provided with the knowledge necessary for such a debate. The manner in which the questions were propounded leaves little room to doubt that the author was deeply versed in the respective subjects they embrace; and the Apology for the accused propositions, particularly those *de Salute Origenis* and *de Magia atque Cabbala*, discover familiarity with the writings of the Fathers, as well as with the Greek and Hebrew classics.

John Pica di Mirandola has been represented by some writers, whose ideas are taken from the encomiums of his contemporaries, as a mighty prodigy of learning and genius. The distaste which the present times entertain towards the subjects upon which he wrote renders it very difficult, upon a review of his works, to believe these encomiums well founded. But, making allowance for this change of opinion, it may be fairly concluded that he was, in reality, a man of very extraordinary powers.

PICARD, John, an able mathematician, and one of the most learned astronomers of the seventeenth century, was born at Flêche, and became priest and prior of Rillie in Anjou. Going to Paris, he was in 1666 received into the Academy of Sciences in quality of astronomer. In 1671, he was sent, by order of the king, to the castle of Uraniburg, built by Tycho Brahé, in Denmark, in order to make astronomical observations there; and thence he brought the original manuscripts written by Tycho Brahé, which are of the greater value as they differ in many places from the printed copies, and contain a book more than has yet appeared. He made important discoveries in astronomy, and was the first who travelled through several parts of France to measure a degree of the meridian. His works are, 1. A Treatise on Levelling; 2. Fragments of Dioptrics; 3. Experimenta circa Aquas effluentes: 4. De Mensuris; 5. De Mensura Liquidorum et Aridorum; 6. A Voyage to Uraniburg, or astronomical observations made in Denmark; and, 7. Astronomical Observations made in several parts of France. These, and some other of his pieces, are contained in the sixth and seventh volumes of the Memoirs of the Academy of Sciences.

PICARDS, a religious sect which arose in Bohemia in the fifteenth century. Picard, the author of this sect, and from whom it has derived its name, drew after him, as has been generally said, a number of men and women, pretending that he would restore them to the primitive state of innocence in which man was created; and accordingly he assumed the title of the *New Adam*. With this pretence he taught his followers to give themselves up to all impurity, saying that therein consisted the liberty of the sons of God; and that all those not of their sect were in a state of bondage. He first published his notions in Germany and the Low Countries, and, persuading many people to go naked, he gave them the name of *Adamites*. After this he seized upon an island in the river Lausnecz, some leagues from Thabor, the head-quarters of Zisca, where he fixed himself and his followers. His women were common, but none were allowed to enjoy them without his permission; so that when any man desired a particular woman, he carried her to Picard, who gave him leave in these words, "Go, increase, multiply, and fill the earth." At length, however, Zisca, general of the Hussites, scandalized at their abominations, marched against them, made himself master of their island, and put them all to death except two, whom he spared that he might learn their doctrine. Such is the account which various writers, relying on the authorities of Æneas Sylvius and Varillas, have given of the Picards, who appear to have been a party of the Vaudois, who fled from persecution in their own country, and sought refuge in Bohemia. It is indeed doubtful whether a sect of this denomination, chargeable with such wild principles and such licentious conduct, ever existed; and it is certainly astonishing that Mr Bayle should adopt the reproachful representations of the writers just mentioned; for it appears probable, at least, that the whole is a calumny invented and propagated in order to disgrace the Picards, merely because they deserted the communion and protested against the errors of the church of Rome. Lasitius informs us, that Picard, together with forty other persons, besides women and children, settled in Bohemia in the year 1418. Balbinus the Jesuit, in his *Epitome Rerum Bohemicarum* (lib. ii.), gives a similar account, and charges against the Picards none of the extravagances or crimes ascribed to them by Sylvius. Schlecta, secretary of Ladislaus, king of Bohemia, in his letters to Erasmus, in which he gives a particular account of the Picards, says that they considered the pope, cardinals, and bishops of Rome, as the true Antichrists, and the adorers of the consecrated elements in the eucharist as downright idolaters; that they denied the corporeal presence of Christ in this sacrament; that they condemned the worship of saints, prayers for the dead, auricular confession, the penance imposed by priests, the feasts and vigils observed in the Catholic church; and that they confined themselves to the observance of the Sabbath, and of the two great feasts of Christmas and Pentecost. From this account it would appear that they were no other than the Vaudois; and M. de Beausobre has clearly shown that they were both of the same sect, though under different denominations. Besides, it is certain that the Vaudois were settled in Bohemia in the year 1178, where some of them adopted the rites of the Greek, and others those of the Latin church. The former were pretty generally adhered to till the middle of the fourteenth century, when the establishment of the Latin rites caused great disturbance. Upon the commencement of the national troubles in Bohemia, on account of the opposition to the papal power, the Picards more publicly avowed and defended their religious opinions; and they formed a considerable body in an island by the river Launitz or Lausnecz, in the district of Bechin, and, recurring to arms, were defeated by Zisca.

PICCOLOMINI, Alexander, archbishop of Patrass, was a native of Sienna, where he was born about the year 1508, being descended of an ancient and illustrious family, which came originally from Rome, but afterwards settled at Sienna. He composed with success for the theatre; but he was more distinguished for his genius, than for the purity of his manners, and his regard to virtue. His charity was great, and chiefly exerted in relieving the necessities of men of letters. He left behind him a number of works in Italian, the most remarkable of which are, 1. Various Dramatic Pieces, which laid the first foundation of his character as a writer; 2. A Treatise on the Sphere; 3. A Theory of the Planets; 4. A Translation of Aristotle's Art of Rhetoric and Poetry, in 4to; and, 5. A System of Morality, published at Venice, 1575, in 4to, translated into French by Peter de Larivey, and printed at Paris, 1581, in 4to. These, with a variety of other works, prove his extensive knowledge in natural philosophy, mathematics, and theology. He was the first who made use of the Italian language in writing upon philosophical subjects. He died at Sienna on the 12th of March 1578, at the age of seventy.

Piccolomini, *Francis*, of the same family with the preceding, was born in the year 1520, and taught philosophy with success for the space of twenty-two years, in the most celebrated universities of Italy, and afterwards retired to Sienna, where he died in 1604, at the age of eighty-four. This city went into mourning on the occasion of his death. His works are, 1. Some Commentaries upon Aristotle, printed at Mayence, 1608, in 4to; and, 2. Universa Philosophia de Moribus, printed at Venice, 1583, in folio. He laboured to revive the doctrine of Plato, and endeavoured also to imitate the manners of that philosopher. He had as his principal rival the famous James Zabarella, whom he excelled in facility of expression and neatness of discourse, but to whom he was much inferior in point of argument, because he did not examine matters to the bottom as the other did, passing too rapidly from one proposition to another.

Piccolomini, *James*, whose proper name was *Ammanati*, took that of *Piccolomini* in honour of his patron Pius II. He was born in a village near Lucca, in 1422. He became Bishop of Massa, and afterwards of Frescati; was made a cardinal in 1461, under the name of Cardinal of Pavia; and died in 1479, at the age of fifty-seven, of an indigestion, occasioned by eating too freely of figs. His works, which consist of some Letters, and a history of his own time, were printed at Milan in 1521, in folio. His history, entitled *Commentaries*, commences with the 14th of June 1464, and ends with the 6th of December 1469. They may very properly be considered as a sequel to the Commentaries of Pope Pius II., which end with the year 1463.

PICKERING, a market-town of the north riding of the county of York, 222 miles from London, and six from York. It is situated in a mountainous district, and it had formerly a castle. The church is very large. There is a good market, which is held on Monday. The population amounted in 1801 to 1994, in 1811 to 2332, in 1821 to 2746, and in 1831 to 2555.

PICKET, an out-guard posted in advance of an army, to give notice of the approach of an enemy.

Picket, a kind of punishment so called, where a soldier stands with one foot upon a sharp-pointed stake; the time of his standing being limited according to the nature of the offence of which he has been found guilty.

PICKETS, in fortification, are stakes sharpened at one end, and sometimes shod with iron, being used in laying out the ground. They are about three feet in length, but when used for pinning the fascines of a battery they are made from three to five feet in length.

Pickets, in artillery, are about five or six feet in length, and shod with iron, being used to pin the lines, in laying out the boundaries of the park.

Pickets, in the camp, are also stakes of about six or eight inches in length, being used to fasten the tent cords in pitching the tents; also stakes of about four or five feet in length, driven into the ground near the tents of the cavalry, to tie the horses to.

PICO, one of the Azores, is so called from some lofty mountains on the island; or rather from one very high mountain, terminating, like Teneriffe, in a peak, and reputed by some writers to be equal to it in height. See Azores.

PICTET, Benedict, a celebrated divine, descended of a distinguished family. He was born at Geneva in 1655; prosecuted his studies with great success; and after having travelled into Holland and England, he taught theology in his own country, with an extraordinary reputation. The university of Leyden, after the death of Spantreina, solicited him to come and fill the place of that eminent person; but he thought that his own country had the best right to his services, and for this generosity on his part he received its thanks through the members of council. A languishing disorder, occasioned by excessive fatigue, hastened his death, which happened on the 9th of June 1724, at the age of sixty-nine years. This minister had much sweetness and affability in his manner; and the poor found in him a comforter and a friend. He published in Latin and French a great number of works, which are much esteemed in Protestant countries. The principal of these are, 1. A System of Christian Theology, in Latin, in three vols. 4to, the best edition of which is that of 1721; 2. Christian Morality, printed at Geneva, 1710, in eight vols. 12mo; 3. the History of the Eleventh and Twelfth Centuries, intended as a sequel to that of Sueur, printed in 1713, in two vols. 4to; 4. Several controversial treatises; 5. A great number of tracts on morality and piety, amongst which we must distinguish the Art of Living and Dying Well, published at Geneva, 1705, in 12mo; 6. Some Letters; 7. Sermons, from 1697 to 1721, in four vols. 8vo; with a vast number of other pieces, the names of which it would be tedious to mention, but which, as M. Sennebier says, "all show evident marks of piety and good sense."

PICTOU. See Nova Scotia.

PICTS, the name of one of those nations who anciently possessed the north of Britain. It is believed by some writers that they were so called from their custom of painting their bodies; an opinion which Camden supports with considerable erudition. It is certainly liable, however, to many objections; for as this custom prevailed amongst the other ancient inhabitants of Britain, who used the *glastum* of Pliny and the *vitrum* of Mela for the same purpose, it may be asked why the name of *Picti* was confined by the Romans to only one tribe, when it was equally applicable to many others? Why should they designate them only by an epithet, without ever annexing their proper name; or why should they impose a new name upon this people alone, when they gave their proper names to all the other tribes which they had occasion to speak of? As these questions cannot be answered in any satisfactory manner, it is plain that we must look for some other derivation of the name.

The Highlanders of Scotland express the name of this once famous nation by the term *Pictich;* a word familiar to the ears of the most illiterate, who could never have derived it from the Roman authors. But the word *Pictich* signifies *pilferers* or *plunderers;* and the appellation was probably imposed upon this people by their neighbours, or assumed by themselves, some time after the reign of Caracalla, when the unguarded state of the Roman province, on which they bordered, afforded them frequent opportunities of making incursions, and committing depredations therein. Accordingly the name appears to have been unknown until the end of the third century. Eumenius the Panegyrist is the first Roman author who mentions this people under their new name of *Pictich,* or, with a Latin termination, *Picti.* But when we say that this name may have probably been assumed for the reason just now mentioned, we must observe, that, in those days of violence, the character of robber was not attended with any disgrace. If a person of this description had the address to lay his schemes well, and to execute them successfully, he was rather praised than blamed for his conduct, providing he made no encroachments upon the property of his own tribe, or that of any of its allies. Nor is this any peculiar stigma upon the Picts; for other nations of antiquity, in the same rude state, thought and acted as they did in such circumstances.[1]

Concerning the origin of the Picts, authors are very much divided in opinion. Boethius derives them from the Agathyrsians, Pomponius Lætus from the Germans, Bede from the Scythians, Camden and Father Innes from the ancient Britons, Stillingfleet from a people inhabiting the Cimbrica Chersonesus, and Keating and O'Flaherty, on the authority of the Cashel Psalter, from the Thracians. But the most probable opinion is, that they were the descendants of the ancient Caledonians. Several very cogent reasons have been urged in support of this opinion by Pinkerton and others; and the words of Eumenius, "Caledonum, *aliorumque* Pictorum, silvas," plainly imply that the Picts and Caledonians were one and the same people. But the question arises here, Of what race were the ancient Caledonians? Were they of Celtic origin, or were they of northern or Scythian descent, a branch of that great family which everywhere overran and occupied the territories possessed by the Celts? Each of these opinions has found its advocates, and has been supported by much erudition and ingenuity; but, without entering into the discussion of a subject so little interesting to the generality of readers, it may be sufficient to state, that the preponderance of evidence and authority is clearly in favour of the latter hypothesis, which Pinkerton has rendered as clear as any matter of this kind can be expected to be made.

As there has been great difference of opinion about the origin of the Picts, so there has likewise been much dispute about their language. There are several reasons which, according to some, make it plain that their tongue was the Gaelic or Celtic; and these reasons are considered as a further confirmation of their having been of Caledonian origin. Through the eastern and north-eastern coasts of Scotland, which were possessed by the Picts, we meet with an innumerable list of names of places, rivers, mountains, and other natural objects, which, it is said, are manifestly Gaelic. From a very old register of the priory of St Andrews,[2] it appears, that in the days of Hungus, the last Pictish king of that name, St Andrews was called *Mukross;* and that the town now called *Queensferry* had then the name of *Ardchinneachan.* But both these words are claimed as Gaelic. The former, we are told, signifies the heath or promontory of boars; and the latter, the height or peninsula of Kenneth. In the list of Pictish kings published by Father Innes, most of the names are apparently Gaelic, and in many instances the same with the names in the list of Scottish or Caledonian kings published by the same author. But Innes understood nothing of that language, and certainly his nomenclature is as little to be relied on as some of his etymologies. Besides, he forgets that the predominance of the Celts at a period long anterior to the settlement of the Picts, and the traces of their language still to be found in the names of places and natural objects, are points which, as far as we know, have never been seriously disputed. This, however, does not prove that the Picts were a branch of the great Celtic family, and there is no good evidence to show that they ever spoke the language of that people. On the contrary, it seems highly probable that they were of German or Scandinavian origin; and although almost no remains of their language now exist, it may be proved negatively, as indeed Pinkerton has done, that it could not have been Celtic.

The Picts of the earliest ages, as appears from the joint testimony of all writers who have examined the subject, possessed only the eastern and north-eastern coast of Scotland. On one side, the ancient Drumalbin, or that ridge of mountains reaching from Lochlomond, near Dumbarton, to the Moray Frith, was the boundary of the Pictish dominions. Accordingly we find in the life of St Columba, that, in journeying to the palace of Brudius, king of the Picts, he travelled over Drumalbin, the *Dorsum Britanniæ* of Adomnan. On the other side, the territory of the Picts was bounded by the Roman province. After Britain was abandoned by the Emperor Honorius, the Picts and the Saxons were by turns masters of those countries which lie between the Frith of Forth and the river Tweed. We learn from Bede, that when he finished his Ecclesiastical History, the Saxons were masters of Galloway. The Picts, however, soon afterwards made a conquest of that country; so that, before the extinction of their monarchy, all the territories bounded on the one side by the Forth and the Clyde, and on the other by the Tweed and the Solway Frith, fell into their hands.

The history of the Picts, as well as that of all the other ancient inhabitants of Britain, is involved in great obscurity. The Irish historians give us a long list of Pictish kings, who reigned over Pictavia for the space of twelve or thirteen centuries before the Christian era. After them, Innes, in his Critical Essay, gives us a list of above fifty, of whom no less than five are said to have swayed the sceptre, each for a whole century. It is probable that these writers confounded the history of the Picts with that of their ancestors the ancient Caledonians. In any other view, their accounts of this people are highly fabulous, and undeserving of serious attention. The Picts, as has already been observed, were probably not known by that name before the third century; at least the first mention of them is made by Eumenius the Panegyrist, in the passage already referred to. Further, Adomnan, abbot of Iona, is the first author who expressly mentions any Pictish king; and the next after him is the Venerable Bede. We are informed by these two writers that St Columba converted Brudius, king of the Picts, to the Christian faith. But St Columba landed in Britain in the year of our era 565. Before that period we have no general record from which to ascertain so much as the name of any Pictish king. The history of *Drust* or *Drost,* who is said to have reigned over the Picts in the beginning of the fifth century, when St Ninian first preached the gospel to that nation, has all the appearance of fiction.[1] His having reigned a hundred years, and his putting an end to a hundred wars, are stories which exceed all the bounds of probability.

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[1] See Thucydides, lib. iii. p. 3; and Virgil, *Æn.* vii. 745 and 749.

[2] Dalrymple's Collections, p. 122.

Brudius, the contemporary of St Columba, is therefore the first Pictish king mentioned by any writer of authority. But what figure his ancestors made, or who were his successors on the throne of Pictavia, cannot be ascertained. Bede informs us, that, during the reign of one of them, the Picts killed in battle Egfred, king of Northumberland, and destroyed the greater part of his army. The same author mentions another of their kings called *Naitan*, for whom he had a particular regard. It was to this Naitan that Ceolfrid, abbot of Wiremouth, wrote his famous letter concerning Easter and the Tonsure;[2] a letter in which Bede himself is supposed to have had a principal hand. Roger Hoveden and Simon of Durham mention two other Pictish kings, *Onnust* and *Kinoth;* the former of whom died in 761, whilst the latter flourished about the year 744, and gave an asylum to Alfred of Northumberland, who about that time was expelled from his kingdom. The accounts given by the Scottish historians, of several other Pictish kings, cannot be depended on; nor are the stories told by the British historians, Geoffroy of Monmouth and the author of the *Eulogium Britanniæ*, worthy of much greater credit.

Towards the close of the ninth century, the Pictish nation was totally subdued by, or rather amalgamated with, the Scots, in the reign of Kenneth Macalpin. Since that time their name has been lost in that of the conquerors, with whom they were incorporated; but they seem to have been treated by the Scottish kings with great lenity, so that for some ages afterwards they commanded great respect. The prior of Hogulstead, an old English historian, relates, that they made a considerable figure in the army of David the Saint, in his disputes with Stephen the king of England. In a battle fought in the year 1136, by the English on one side, and the Scots and Picts on the other, the latter insisted on their hereditary right of leading the van of the Scottish army, and were indulged in that demand by the king.

The principal seat of the Pictish kings was at Abernethy. Brudius, however, as appears from the accounts given by Adomnan, in his life of St Columba, had a palace at Inverness, which was probably near the extremity of his territory in that quarter; for there is no good reason to believe, with Camden, that this king had any property in the Western Isles, or that he made a gift of Iona to St Columba when he visited the saint in that island.

With respect to the manners and customs of the Picts, there is no reason to suppose that they were any other than those of the ancient Caledonians, of which many particulars are related by the Greek and Roman writers who have occasion to speak of those nations. Upon the decline of the Roman empire, cohorts of barbarians were raised, and Picts were invited to enter the service by Honorius; and when peace was everywhere restored, they were named *Honoriaci*. Those of them who served under Constantine opened the passes of the Pyrenean mountains, and let the barbarous nations into Spain. From this period may be dated the civilization of their manners, which happened after they had, first by themselves, and afterwards with the assistance of the Scots, ravaged the Roman province. This brought them in contact with civilization, and they profited by the collision.

PICTS' *Wall*, in *Antiquity*, a wall begun by the Emperor Hadrian, on the northern boundaries of England, to prevent the incursions of the Picts and Scots. It was at first made only of turf strengthened with palisades, but the Emperor Severus, coming in person into Britain, built it of solid stone. This wall, part of which still remains, began at the entrance of the Solway Frith, in Cumberland, and running north-eastward, extended to the German Ocean.

PICTURE, a piece of painting, or a subject represented in colours, on wood, canvass, paper, or some other substance. See PAINTING.

PICTURESQUE literally signifies that which is capable of, or fitted for, pictural delineation. Picturesque beauty, says an able writer on that subject, refers to such beautiful objects as are suited to the pencil. This epithet is chiefly applied to the works of nature, though it will often apply also to works of art. Those objects are most properly denominated picturesque which are disposed by the hand of nature with a mixture of varied rudeness, simplicity, and grandeur. A plain neat garden, with little variation in its plan, and no striking grandeur in its position, displays too much of art, design, and uniformity, to be called picturesque. "The ideas of neat and smooth," says Mr Gilpin, "instead of being picturesque, in fact disqualify the object in which they reside from any pretensions to picturesque beauty. Nay, farther, we do not scruple to assert, that roughness forms the most essential point of difference between the beautiful and the picturesque; as it seems to be that particular quality which makes objects chiefly pleasing in painting. I use the general term *roughness;* but, properly speaking, roughness relates only to the surfaces of bodies; when we speak of their delineation, we use the word *ruggedness.* Both ideas, however, equally enter into the picturesque, and both are observable in the smaller as well as in the larger parts of nature; in the outline and bark of a tree, as in the rude summit and craggy sides of a mountain."

PICUMNUS and PILUMNUS were two Roman deities, who presided over the auspices required before the celebration of nuptials. Pilumnus was supposed to patronize children, as his name seems in some manner to indicate, "quod pellat mala infantiæ." The manuring of the land was first invented by Picumnus, for which reason he is also called *Sterquilinius.* Pilumnus was also invoked as the god of bakers and millers, because he was said to have first invented the art of grinding corn.

PIEDMONT, or PIEMONT, a principality and principal province of the continental states of the Sardinian monarchy, forming the north-western portion of Italy. It was separated from Sardinia by the French in the year 1798, and in 1802 incorporated with France. On the fall of Napoleon in 1814 it was restored to the king of Sardinia, and the duchies of Milan and Montferrat have been annexed to it. It is now divided into twenty-six districts. Piedmont, in a narrower sense, borders on the Valais and Savoy to the north, on France to the west, on Nice and Genoa to the south, and on the Sardinian Milanese and Montferrat to the east. These limits comprise an area of 6575 square miles, and contain a population of 1,400,000 souls. If we include the Sardinian Milanese and Montferrat, its superficial extent is above 12,000 square miles, and the inhabitants amount to 2,322,000. It forms a continuation of the plain of Lombardy, somewhat narrowed, and more closely bounded by the mightiest ranges of the Alps and Apennines; the former on the north and west, the latter on the south. The principal river is the Po, which runs through its centre, dividing it into two nearly equal parts; and it receives here nearly all its early tributaries, which, from being in the vicinity of their mountain sources, are liable to sudden and destructive inundations. The climate, of course, varies according to the elevation of the surface. In the mountainous regions in the north and west the snow and ice remain during a great portion of the year. In the plains the climate is temperate during winter, and the excessive heats of summer are tempered by the vicinity of the Alps. The soil generally is very fertile, the plains traversed by the Po being particularly prolific, and in a high state of cultivation. They yield in abundance corn, wine, oil, fruits, rice, and hemp. But the staple product is silk, the breeding of the silk-worm being nowhere in Italy carried to the same extent; and the produce is also reckoned the finest in quality. It produces yearly 22,000,000 *lire* worth of silk, most of which is exported in the raw state. Another important branch of industry is the breeding of cattle, the pastures being both extensive and rich. The hills are in general covered with vineyards, the produce of which is very abundant, but generally of inferior quality. Olives, almonds, chestnuts, and in smaller quantities figs, oranges, and lemons, are raised here. The northern, western, and southern districts supply the central region with wood. The Piedmontese are industrious and frugal, and are all Catholics, with the exception of about 20,000 Waldenses and a few Jews. They have some silk, linen, and woollen manufactures, and thousands of them are seen travelling about Italy, France, and Germany as pedlars. The capital of Piedmont is Turin. This province derives its name from its situation at the foot of the mountains.

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[1] According to Camden, this conversion happened about the year 630, in the southern Pictish provinces; whilst the northern, which were separated by mountains, were converted by St Columba.

[2] We are told by some authors that St Columba taught the Picts to celebrate Easter always on a Sunday between the 14th and 20th of March, and to observe a different method of tonsure from the Romans, leaving an imperfect appearance of a crown. This occasioned much dispute, till Naitan at length brought his subjects to the Catholic rule. In that age many of the Picts went on a pilgrimage to Rome, according to the custom of the times; and amongst the rest we find two persons mentioned in the Antiquities of St Peter's Church. *Asterius*, count of the Picts, and *Syra*, with some of his countrymen, performed their vow.

PIEDMONTE, a town of Italy, in the province Terra di Lavoro, and the kingdom of Naples. It is situated at the foot of the mountain Matese, and has wide streets, well-built houses, seven churches, a hospital, and 4640 inhabitants, who make woollen cloths, paper, and iron ware.

PIER, in building, denotes a mass of stone, opposed by way of fortress to the force of the sea or a great river, for the security of ships which lie at harbour in any haven.

PIERCY Island, a small island near the east coast of New Zealand, a little to the east of Cape Brett.

PIERHEAD, a promontory on the north-east coast of New Holland, and the west point of Thirsty Sound.

PIERIDES, in fabulous history, the daughters of Pierus, a Macedonian prince, who, presuming to dispute with the muses for the prize of poetry, were turned into magpies. The name of *Pierides* was also given to the muses, from Mount Pieris in Thessaly, which was consecrated to them; or, according to others, from Pieris, a Thessalian poet, who was the first who sacrificed to them.

PIERINO del Vaga, an eminent Italian painter, the son of poor parents, and a native of Tuscany, was born about the year 1500. He was placed apprentice with a grocer in Florence, and got some instructions from the painters to whom he was sent with colours and pencils; but an artist named Vaga taking him to Rome, he was called *Del Vaga*, from living with him, his real name being Buonacorsi. He studied anatomy and the other sciences necessary for his profession, and had somewhat of everything that was good in his compositions. After Raffaelle's death, he united with Julio Romano and Francisco Penni in finishing the works in the Vatican which were left imperfect by their common master; and, to confirm their friendship, he married Penni's sister. He gained the highest reputation by his performances in the palace of Prince Doria at Genoa; but the multiplicity of his occupations, and the vivacity of his imagination, exhausted his spirits in the flower of his age; and he died in the year 1547.

PIETISTS, a religious sect which sprung up amongst the Protestants of Germany, being a kind of mean between the Quakers of England and the Quietists of the Catholic church. They despised all sorts of ecclesiastical polity, all scholastic divinity, and all forms and ceremonies, and gave themselves up to contemplation and a mystic theology. Many gross errors are charged on the Pietists, in a book entitled *Manipulus Observationum Antipietisticarum;* but these have much of the air of polemical exaggeration, and are certainly not at all just. Indeed there are Pietists of various kinds; some running into gross illusions, and carrying their errors to the overturning of the greater part of Christian doctrine, whilst others are only visionaries, and a few are very honest and good, though perhaps misguided, people. Having become disgusted with the coldness and formality of other churches, they were charmed with the fervent piety of the Pietists, and attached to their party, without giving in to the grossest of their errors.

PIETRA Mala, a market-town of Italy, in the vicariate of Firenzuolo, and the grand duchy of Tuscany. It stands on the great road from Florence to Bologna, twenty-four miles to the north-west of the former city. It is remarkable from its vicinity to the mountain Raticosa, from which there issues constantly, on some parts of its surface, a flame, which does not produce those effects that commonly arise from volcanic eruptions. It burns both clear and bright, rises several feet above the earth, and is visible at a considerable distance. Various opinions and conjectures have been formed by naturalists concerning the causes and nature of this phenomenon, but none has been considered as satisfactory.

PIETRA Percia, a town of the island of Sicily, in the intendancy of Calatinata, and district of Noto. It is situated on a steep inland mountain, near the river Salso, seventy-four miles from Palermo, and is a healthy place, containing 8290 inhabitants.

PIETRI de Fusi, a town of Italy, in the province Principato Ulteriore, and the kingdom of Naples. It contains 4890 inhabitants, who grow some excellent wine.

PIETY is a virtue which denotes veneration for the Deity, and love and tenderness to our friends. This distinguished virtue, like many others, received amongst the Romans divine honours, and was made one of their gods. Acilius Glabrio first erected a temple to this divinity, which he built upon the spot on which a woman had fed with her own milk her aged father, who had been imprisoned by order of the senate, and deprived of all aliments.

PIGEON. See Ornithology.

Pigeon *Island*, in Dusky Bay, New Zealand, a little to the south of Facile Harbour. This is also the name of another island in the Eastern Seas, near the coast of Canara. Long. 74. 5. E. Lat. 14. 2. N.

PIKE. See Ichthyology.

PILATE, or Pontius Pilate, was governor of Judæa when our Lord was crucified. Of his family or country we know little, though it is believed that he was a native of Rome, or at least of Italy. He was sent to govern Judæa in the room of Gratus, in the year 26 or 27 of the common era, and he governed this province for ten years, that is, from the twelfth or thirteenth to the twenty-second or twenty-third year of Tiberius. He is represented, both by Philo and by Josephus, as a man of an impetuous and obstinate temper, and, as a judge, accustomed to sell justice, and to pronounce any sentence that was desired, provided he was paid for it. The same authors mention his rapines, his injuries, his murders, the torments he inflicted upon the innocent, and the persons he put to death without any form of process. Philo, in particular, describes him as a

Pilate.

man who exercised excessive cruelty during the whole time of his government, disturbed the repose of Judæa, and gave occasion to the troubles and revolt which followed. St Luke (xiii. 1, 2, et seq.) acquaints us that Pilate had mingled the blood of the Galileans with their sacrifices, and that the matter having been related to our Lord, he said, "Suppose ye that these Galileans were sinners above all the Galileans, because they suffered such things? I tell you, nay; but except ye repent, ye shall all likewise perish." It is not known upon what particular occasion Pilate caused these Galileans to be slain in the temple whilst they were sacrificing; for this is the meaning of the expression about mingling their blood with their sacrifices. Some think they were disciples of Judas the Gaulonite, who taught that the Jews ought not to pay tribute to foreign princes, and that Pilate had put some of them to death even in the temple; but there is no proof of this fact. Others are of opinion that these Galileans were Samaritans, whom Pilate cut to pieces in the village of Tirataba,[1] as they were preparing to go up to Mount Gerizim, where a certain impostor had promised to discover to them treasures; but this event did not happen before the year 35 of the common era, and consequently two years after the death of Jesus Christ. At the time of our Saviour's passion, Pilate made some faint endeavours to rescue him out of the hands of the vindictive Jews. He knew that they had delivered him up, and pursued his life with so much violence, solely out of malice and envy (Matt. xxvii. 18). His wife, also, who had been disturbed the night before with frightful dreams, sent to tell him that she desired him not to meddle in the affair of that just person (*ibid.* 19). He attempted to appease the wrath of the Jews, and to give them some satisfaction, by scourging our Lord (John, xix. 1; Matt. xxvii. 26). He also tried to take him out of their hands by proposing to deliver him or Barabbas, on the day of the festival of the passover. Lastly, he had a mind to discharge himself from pronouncing judgment against him by sending him to Herod king of Galilee (Luke, xxiii. 7, 8). But when he saw that all this would not satisfy the Jews, and that they even in a manner threatened him, saying he could be no friend to the emperor if he let him go (John, xix. 12, 15), he caused water to be brought, and having washed his hands before all the people, publicly declared himself innocent of the blood of Jesus, in whom he found no fault (Matt. xxvii. 23, 24); though at the same time this miserable juggler with conscience delivered him up to his soldiers that they might crucify him. His conduct, however, was sufficient to justify Jesus Christ, as Calmet observes, and to show that the governor held him to be innocent; but it was not enough to vindicate the conscience and integrity of a judge, whose duty it was to assert the cause of oppressed innocence, as well as to punish the guilty and criminal. He ordered to be inscribed on our Saviour's cross an abstract as it were of his sentence, and the motive of his condemnation, "Jesus of Nazareth, king of the Jews," which was written in Latin, Greek, and Hebrew. Some of the Jews found fault with it, and remonstrated with Pilate, alleging that he ought to have written "Jesus of Nazareth, who pretended to be king of the Jews." But Pilate could not be prevailed on to alter it, and gave them this peremptory answer, that what he had written he had written.

Towards evening, he was applied to for leave to take down the bodies from the cross, that they might not continue there the following day, which was the passover and the sabbath-day (John, xix. 31). This he allowed, and granted the body of Jesus to Joseph of Arimathea, that he might pay to it his last duties (*ibid.* 33). Lastly, when the priests, who had solicited the death of our Saviour, came to desire him to set a watch upon the sepulchre, lest his disciples should steal him away by night, he answered them, that they had a guard, and might place it there themselves (Matt. xxvii. 65). This is the substance of what the gospel tells us concerning Pontius Pilate.

Justin Martyr, Tertullian, Eusebius, and several other succeeding writers, both ancient and modern, assure us that it was formerly the custom for Roman magistrates to prepare copies of all verbal processes and judicial acts which took place in their several provinces, and to send these to the emperor. Pilate, therefore, in compliance with this custom, having sent intelligence to Tiberius of what had passed relating to Jesus Christ, the emperor wrote an account of it to the senate, in a manner which gave reason to infer that he thought favourably of the religion of Jesus Christ, and showed that he had no serious objection to their decreeing him divine honours. But the senate was not of the same opinion, and so the matter dropped. It appears, from what Justin says of these acts, that the miracles of Jesus Christ were mentioned there, including even the circumstance of the soldiers having divided his garments amongst them. Eusebius insinuates that they spoke of his resurrection and ascension. Tertullian and Justin refer to these acts with so much confidence, that we cannot suppose them to have written without authority. However, neither Eusebius nor St Jerome, who were both inquisitive and intelligent persons, nor any other author who wrote afterwards, seems to have seen these acts, at least not the true and original acts; for as to those which we have now in great number, they are not authentic, being neither ancient nor uniform. There are also some pretended letters of Pilate to Tiberius, giving a history of our Saviour; but they are universally allowed to be spurious.

Pilate being a man who, by his excessive cruelties and rapine, had disturbed the peace of Judæa during the whole time of his government, was at length deposed by Vitellius, the proconsul of Syria, in the 36th year of Jesus Christ, and sent to Rome to give an account of his conduct to the emperor. But though Tiberius died before Pilate arrived at Rome, yet his successor Caligula banished him to Vienne in Gaul, where he was reduced to such extremity that he put himself to death with his own hands. The Evangelists call him governor, although in reality he was only procurator of Judæa.

With regard to Pilate's wife, the general tradition is, that she was named Claudia Procula or Proscula; and in relation to her dream, some are of opinion, that as she had intelligence of our Lord's apprehension, and knew by his character that he was a righteous person, her imagination, being struck with these ideas, had naturally produced the dream we read of; but others think that this dream was sent to her providentially, for the clearer manifestation of our Lord's innocence.

Pilatre de Rozier.

PILATRE DE ROZIER, FRANCIS, was born at Metz on the 30th of March 1756. He was first apprentice to an apothecary there, and afterwards went to Paris in quest of further improvement. He applied himself to the study of natural history and physics, and had already acquired some reputation, when the discovery of Montgolfier astonished the learned world. On the 25th of October 1783, he attempted an aerial voyage, accompanied by the Marquis of Arlande. He performed several other excursions in this way with brilliant success, in the presence of the royal family of France, of the king of Sweden, and of Prince Henry of Prussia. He then resolved to pass into England by means of his aerial vehicle, and for that purpose he repaired to

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[1] Josephus, *Antiq. Jud.* lib. xviii. c. 5.

Boulogne, whence he rose about seven o'clock in the morning on the 15th of June 1785; but in half an hour after he set out, the balloon took fire, and the aeronaut, with his companion M. Romaine, were crushed to death by the fall of the machine. See Aeronautics.

PILCHARD. See Ichthyology.

PILE, in *Heraldry*, an ordinary in the form of a wedge, contracting from the chief, and terminating in a point towards the bottom of the shield.

Pile, amongst the Greeks and Romans, was a pyramid built of wood, upon which were laid the bodies of the deceased, to be burned. It was partly in the form of an altar, and differed in height according to the quality of the person to be consumed. Probably it might originally have been considered as an altar, upon which the dead were consumed as a burnt-offering to the infernal deities. The trees made use of in the erection of a funeral pile were such as abounded in pitch or rosin, and consequently were most combustible; if they used any other wood, it was split that it might the more easily catch fire. Round the pile were placed cypress boughs, to prevent the noisome smell.

Pile, in building, means a large stake rammed into the ground in the bottom of rivers, or in marshy land, for a foundation to build upon.

Pile is also a term amongst architects, signifying a mass of building.

Pile-Engine, a machine for driving the piles upon which the piers of bridges are founded. See Mechanics.

PILEUS, in Roman antiquity, was the ordinary cap or hat worn by the freedmen at public shows and sacrifices. It was one of the common rewards assigned to such gladiators as were slaves, in token of their obtaining freedom.

PILGRIM, one who travels through foreign countries to visit holy places, and to pay his devotion to the relics of saints. The word is formed from the Flemish *pelgrim*, or the Italian *pelegrino*, which signifies the same; and these were originally formed from the Latin *peregrinus*, a stranger or traveller.

PILGRIMAGE, a kind of religious discipline, which consists in taking a journey to some holy place in order to pray before the relics of some saint. Pilgrimages began to be made about the middle ages of the church; but they were most in vogue after the end of the eleventh century, when every one was smitten with a desire of visiting places of devotion, not excepting kings and princes themselves; and even bishops made no difficulty of being absent from their churches on the same account.[1]

Dr Johnson, in his *Rasselas*, gives us some observations on pilgrimage, which are so much to the purpose that we think we cannot do better than lay them before our readers. "Pilgrimage, like many other acts of piety, may be reasonable or superstitious according to the principles upon which it is performed. Long journeys in search of truth are not commanded. Truth, such as is necessary to the regulation of life, is always found where it is honestly sought: change of place is no natural cause of the increase of piety, for it inevitably produces dissipation of mind. Yet since men go every day to view the fields where great actions have been performed, and return with stronger impressions of the event, curiosity of the same kind may naturally dispose us to view that country where our religion had its beginning; and I believe no man surveys those awful scenes without some confirmation of holy resolutions. That the Supreme Being may be more easily propitiated in one place than in another, is the dream of idle superstition; but that some places may operate upon our own minds in an uncommon manner, is an opinion which hourly experience will justify. He who supposes that his vices may be more successfully combated in Palestine, will perhaps find himself mistaken; yet he may go thither without folly: he who thinks they will be more freely pardoned, dishonours at once his reason and religion."

PILKALLEN, a town of the province of East Prussia, and the capital of a circle of the same name, which extends over 410 square miles, and, in two cities and seven parishes, contains 22,100 inhabitants. The town is situated on a small river, and has 120 houses, with 1490 inhabitants. Long. 22. 54. 57. E. Lat. 54. 45. 19. N.

PILKINGTON, Lætitia, a sprightly and once noted writer, was the daughter of Dr Van Lewin, a physician of Dublin, where she was born in the year 1712. She was married when very young to the Rev. Matthew Pilkington, a poet of no inconsiderable merit; and the two wits, as is often the case, lived very unhappily together, and were at length totally separated. The story is told at large in her Memoirs. After this separation, Mrs Pilkington came to London, and lived for some time on the productions of her pen. She was, however, thrown into the Marshalsea for debt; and being set at liberty, opened a pamphlet shop. She at length raised a handsome subscription for her Memoirs, which are written with great sprightliness and wit; containing several anecdotes of Dean Swift, with whom she was intimate, as well as many pretty little pieces of her own poetry. This ingenious person died at Dublin in 1750.

Pilkington, a township in the parish of Prestwick, of the hundred of Salford, in Lancashire, 180 miles from London and four from Manchester. It is chiefly inhabited by cotton manufacturers. The population amounted in 1801 to 5786, in 1811 to 7353, in 1821 to 8976, and in 1831 to 11,006.

PILLAR, Cape, a high cape on the south-east coast of Van Diemen's Land, on the north-eastern shore of Storm Bay. Long. 148. 8. E. Lat. 43. 12. S.

PILLARS, in antiquarian topography, are large single stones set up perpendicularly. Those of them which are found in this country were the work of the Druids; but as they are the most simple of all monuments, they are unquestionably more ancient than even Druidism itself. They were placed as memorials recording different events; as remarkable instances of God's mercies, of contracts, singular victories, boundaries, and sometimes sepulchres. Various instances of these monuments erected by the patriarchs occur in the Old Testament. Such was that raised by Jacob at Luz, afterwards by him named *Bethel;* and such also was the pillar placed by him over the grave of Rachel. They were likewise marks of execrations and magical talismans. These stones, from having long been considered as objects of veneration, were at length idolatrously worshipped by the ignorant and superstitious; wherefore, after the introduction of Christianity, some had crosses cut upon them, which was considered as taking them out of the category of works devoted to the service of the devil. Vulgar superstition of a later date has led the common people to regard them as persons transformed into stone for the punishment of some crime, generally that of sabbath-breaking. This notion, however, is not confined to single stones, but is also told of whole circles; as the monuments called the *hurlers* in Cornwall, and *Rolloric stones* in Warwickshire. The former are by the vulgar supposed to have once been men, who were thus transformed as a punishment for playing on the Lord's day at a game called *hurling;* the latter are believed to consist of a pagan king and his army.

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[1] It deserves to be remarked here, that in the year 1428, under the reign of Henry VI. abundance of licenses were granted by the crown of England to captains of English ships, for carrying numbers of devout persons to the shrine of St James of Compostella, in Spain; provided, however, that those pilgrims should first take an oath not to carry with them any thing prejudicial to England, nor to reveal any of its secrets, nor to take out with them any more gold or silver than what should be sufficient for their reasonable expenses. In this year there went out from England, on the same pilgrimage, from London 280, Bristol 200, Weymouth 122, Dartmouth 90, Yarmouth 60, Jersey 60, Plymouth 40, Exeter 30, Poole 24, Ipswich 20; in all 926 persons.

PILLAU, a city of the province of East Prussia, in the circle of Fischausen. It stands on a tongue of land on the bank of a strait by which the Frisch Haff is connected with the Baltic Sea. It is regularly fortified, and defended by a fortress. The harbour is secure, and admits ships of 200 tons burden, and about 1000 vessels yearly enter and depart. It contains about 200 very large and anciently-fashioned houses, with 3600 inhabitants. It has considerable trade in ship-building, in the fishery, in distilleries and breweries, in corn, and in timber. Long. 19. 48. 21. E. Lat. 54. 38. 18. N.

PILLERE, a small town of Hindustan, in the district of Gurrumcundah, ninety-five miles west-north-west from Madras. Long. 79. 5. E. Lat. 13. 32. N.

PILLIBEET, a town of Hindustan, in the province of Delhi, and district of Bareily. It was a great emporium of commerce in the time of Hafiz Rehmut. After the Rohilla country was laid waste by the nabob of Oude, its commerce was annihilated; but since its cession to the British it has greatly revived.

PILLORY (*collistrigium,* that is, *collum stringens; pilloria,* from the French *pilleur,* meaning *depeculator;* or *pelori,* derived from the Greek πυλη, *janua,* a door, because one standing on the pillory puts his head as it were through a door, and ὁραω, *video*) is an engine made of wood, to punish offenders, by exposing them to public view, and rendering them infamous.

PILOT, an officer who superintends the navigation of a ship, squadron, or fleet, either upon the sea-coast or upon the main ocean. It is, however, more particularly applied by our mariners to the person charged with the direction of a ship's course on or near the sea-coast, and into the roads, bays, rivers, havens, and creeks, within his respective district.

PILSEN, a city of the Austrian kingdom of Bohemia, the capital of a circle of the same name, which extends over 1474 square miles, comprehending fifteen cities, fourteen towns, 669 villages, and 28,500 houses. The city stands at the junction of the rivers Bradawta and Beraunta, and contains 546 houses, and about 8000 inhabitants, who conduct some cloth manufactories, and considerable internal trade in hardware made from mines of iron in its neighbourhood. Near to them are also extensive alum works, both belonging to the city. The place is one of historical celebrity, from having been the scene of the insurrection of Wallenstein against the imperial government in the Thirty Years' War. Long. 13. 18. 45. E. Lat. 49. 44. 38. N.

PILUM, a missive weapon used by the Roman soldiers, and in a charge hurled against the enemy. Its point, we are told by Polybius, was so long and small, that after the first discharge it was generally so bent as to be rendered useless. The legionary soldiers made use of the *pilum,* and each man carried two. The *pilum* underwent many alterations and improvements, insomuch that it is impossible to describe it with any precision. Julius Scaliger laboured much to give an accurate account of it, and would have esteemed success on this head amongst the greatest blessings of his life. Marius made a material improvement on the *pilum;* for during the Cimbrian war, he so contrived it, that when it stuck in the enemy's shield it bent down at an angle in the part where the wood was connected with the iron, and thus became useless to the person who received it.

PILWARA, a town of Hindustan, in the province of Ajmere, and district of Oudipore, belonging to the ranah. Long. 74. 25. E. Lat. 25. 19. N.

PIMENTO, JAMAICA PEPPER, or *Allspice,* a species of *myrtus.* The pimento trees grow spontaneously, and in great abundance, in many parts of Jamaica, but more particularly on hilly situations near the sea, on the northern side of that island, where they form the most delicious groves that can possibly be imagined.

"This tree is purely a child of nature, and seems to mock all the labours of man in his endeavours to extend or improve its growth; not one attempt in fifty to propagate the young plants, or to raise them from the seeds, in parts of the country where it is not found growing spontaneously, having succeeded. The usual method of forming a new pimento plantation (in Jamaica it is called a *walk*), is nothing more than to appropriate a piece of woodland, in the neighbourhood of a plantation already existing, or in a country where the scattered trees are found in a native state, the woods of which being fallen, the trees are suffered to remain on the ground till they become rotten and perish. In the course of twelve months after the first season, abundance of young pimento plants will be found growing vigorously in all parts of the land, being without doubt produced from ripe berries scattered there by the birds, whilst the fallen trees, &c. afford them both shelter and shade. At the end of two years it will be proper to give the land a thorough cleansing, leaving such only of the pimento trees as have a good appearance, which will then soon form such groves as those already described, and, except perhaps for the first four or five years, require very little attention afterwards.

"Soon after the trees are in blossom, the berries become fit for gathering; the fruit not being suffered to ripen on the tree, as the pulp in that state, being moist and glutinous, is difficult to cure, and when dry becomes black and tasteless. It is impossible, however, to prevent some of the ripe berries from mixing with the rest; but if the proportion of them be great, the price of the commodity is considerably injured.

"It is gathered by the hand; one labourer on the tree, employed in gathering the small branches, will give employment to three below, who are generally women and children, in picking the berries; and an industrious picker will fill a bag of 70 lbs. in the day.

"The returns from a pimento walk in a favourable season are prodigious. A single tree has been known to yield 150 lbs. of the raw fruit, or one hundredweight of the dried spice, there being commonly a loss in weight of one third in curing; but this, like many other of the minor productions, is exceedingly uncertain, and perhaps a very plentiful crop occurs but once in five years."

PIN, in commerce, a little necessary instrument made of brass-wire, and chiefly used by women in fastening and adjusting their dress. In the year 1543, by statute 34 and 35 of Henry VIII. c. 6, it was enacted, "That no person shall put to sale any pinnes but only such as shall be double headed, and have the heads soldered fast to the shank of the pins, well smoothed, the shank well shapen, the points well and round filed, cauted, and sharpened." From the above extract it should appear that the art of pin-making was then but of recent invention, being probably introduced from France; and consequently our manufactories must since that period have wonderfully improved.

Though pins are apparently simple, their manufacture is, however, not a little curious and complex. When the brass wire of which the pins are formed is first received at the manufactory, it is generally too thick for the purpose of being cut into pins. The first operation, therefore, is that of winding it off from one wheel to another with great velocity, and causing it to pass between the two, through a circle in a piece of iron of smaller diameter. The wire being thus reduced to its proper dimensions, is straightened by drawing it between iron pins fixed on a board in a zigzag manner, but so as to leave a straight line between them. Afterwards it is cut into lengths of three or four yards, and then into smaller ones, every length being sufficient to make six pins; and each end of these is then ground to a point. When the wire is thus pointed, a pin is taken off from each end, and this is repeated until it has been cut into six pieces. The next operation is that of forming the heads, or, as they term it, *head spinning;* which is done by means of a spinning-wheel, one piece of wire being thus with astonishing rapidity wound round another, and the interior one being drawn out, leaving a hollow tube between the circumvolutions. It is then cut with shears, every two circumvolutions or turns of the wire forming one head; and these are softened by throwing them into iron pans, and placing them in a furnace until they are red hot. As soon as they are cold, they are distributed to children, who sit with anvils and hammers before them, which they work with their feet by means of a lathe, and taking up one of the lengths, they thrust the blunt end into a quantity of the heads which lie before them, and catching one at the extremity, they apply them immediately to the anvil and hammer, and by a motion or two of the foot the point and the head are fixed together in much less time than it can be described, and with a dexterity only to be acquired by practice; the spectator being in continual apprehension for the safety of their finger-ends. The pin is now finished as to its form, but still it is merely brass. It is therefore thrown into a copper containing a solution of tin and the lees of wine. Here it remains for some time, and when taken out assumes a white though dull appearance. In order, therefore, to give it a polish, it is put into a tub containing a quantity of bran, which is set in motion by turning a shaft that runs through its centre, and thus by means of friction it becomes perfectly bright. The pin being complete, nothing remains but to separate it from the bran, which is performed by a mode exactly similar to the winnowing of corn; the bran flying off and leaving the pin behind fit for immediate sale.

PINACIA, amongst the Athenians, were tablets of brass inscribed with the names of all those citizens in each tribe who were duly qualified and willing to become judges of the court of Areopagus. These tablets were cast into a vessel provided for the purpose, and the same number of beans, a hundred being white and all the rest black, were thrown into another. Then the names of the candidates and the beans were drawn out one by one, and they whose names were drawn out together with the white beans were elected judges or senators. In Solon's time there were only four tribes, each of which chose a hundred senators; but the number of tribes being afterwards increased, that of senators and judges was also increased to so many hundreds more.

PINAGRA, a town and fortress of the south of India, in the district of Baramahal, ninety-five miles east by south from Seringapatam. Long. 78. 8. E. Lat. 12. 6. N.

PINCHBECK, a factitious metallic substance, or an alloy of three parts of zinc and four of copper.

PINDAR, the most celebrated lyric poet that Greece produced, was a native of Thebes in Bœotia, and born B. C. 518, forty years before the expedition of Xerxes. He was the contemporary of Æschylus, but younger than Simonides, and somewhat older than Bacchylides. It was scarcely to be expected that the early years of such a distinguished poet should pass without some extraordinary event taking place, and it is accordingly stated that he was exposed on a desert mountain, and that he was fed by bees. Whether his father's name was Diophantus or Scopelinus is uncertain, but he was of the humble profession of a player on the flute, which he at first intended that his son should pursue. Finding, however, that his talents entitled him to occupy a higher position in the drama of life, he placed him under Lasus of Hermione, a poet who then enjoyed a high reputation. Although he lived in one of the most eventful periods of Grecian history, it does not appear that he took any active part in the political struggles of his country. It has been even doubted whether his feelings in favour of the liberty of Greece were so ardent as to induce him to oppose the progress of the Persians. Before the battle of Platæa a seditious movement had taken place in Thebes, and a strong party had joined the Persians. In a passage of the poet written at this period, Polybius imagines he can satisfactorily discover that Pindar was the advocate of this step, and of course visits him with not unmerited reproach. Stobæus, however, gives this same passage more fully, and it there appears that the poet recommends peace, not in reference to the Persians, but to his fellow-citizens, who were tearing one another to pieces in civil broils. But a still stronger proof that Polybius had taken a prejudiced view of his character, is found in the circumstance that the poet wrote a dithyrambic poem after the battle of Platæa, in which he spoke so warmly in admiration of Athens, that the prevailing party amongst his countrymen took umbrage at it, and visited him with punishment. The Athenians, on the other hand, erected a statue to his honour. Again we find him comparing the victories of Hiero at Cumæ and Himera to the most illustrious engagements of the Greeks against the Persians. It is impossible, therefore, to doubt that he joined heartily in support of Greek independence, though he does not seem to have thought that a monarchical government, justly and mildly administered, was unworthy of respect. Of his private history nothing farther is known, except that he died at an advanced age, probably about the year B. C. 439. According to one tradition, he died whilst he was resting on the bosom of his young disciple Theoxenus, after he had taken part in the active exercises of the gymnasium. He was the writer of many poems, but they have all perished except some fragments, and those hymns which he composed in honour of the conquerors at the solemn games of Greece. They are divided into four books, of which the first contains those who had conquered at the Olympic games, and consists of fourteen odes; the second, addressed to the conquerors of the Pythian games, contains twelve odes; the third, addressed to the Nemean conquerors, contains eleven odes; and the fourth, celebrating the Isthmian conquerors, contains eight odes. It is difficult to believe that the reputation of Pindar was founded upon the poetry which has come down to us, and indeed his dithyrambic hymns are spoken of as his finest productions. He is no doubt distinguished by a warm and enthusiastic genius, and by bold and figurative expressions; but the abruptness of his transitions, and the numerous allusions to persons and things now altogether unknown, and which, if known, would not interest the reader, very much diminish the pleasure with which his poetry is read. Still the opinion of Horace must for ever place him in the foremost rank of lyric poets.

> Fiery, immense, profound he flowes
> As from a mountaine tumbling goes
> A torrent fed with showers, flyes o'er
> The well-knowne limits of the shore.
> Apollo's bayes are due to him,
> Whether new words swolne to the brim,
> He (bold) through dithyrambics throw,
> Where every new word doth loosely flow;
> Whether gods, kings, or gods' allies
> He chant, who by a just surprise,
> The Centaurs vanquish'd, and supprest
> Chimæra's dreadful flaming crest.
>
> *Hawkins' Translation,* 1625.

The oldest edition of this poet is that of Aldus, Venice, 1513, in 8vo. The best editions are those by Erasmus Schmid, Wittenburg, 1616, in 4to; by Heyne, Göttingen, 1773; by Aug. Böckh, Leipzig, 1811–1822, particularly valuable for criticism and metre; by Thiersch, with a German translation, Leipzig, 1820, in 8vo; Pindari Carmina commentario perpetuo illustravit L. Dissen, Goth., 1830, in 8vo; Schneider de Vitâ et Scriptis Pindari, Strasburg, 1774, in 8vo.

PINDAR RIVER, a small river of Northern Hindustan, in the province of Serinagur, which afterwards joins the Alcananda.

PINDTARUK, a small village of Hindustan, in the Gujerat peninsula, situated in a sandy plain. There is a spring of pink-coloured water in the vicinity, which is celebrated amongst the natives as a place of pilgrimage.

PINEDA, JOHN, an historian of some note, was descended of a noble family, and born at Seville. He entered into the society of the Jesuits in 1572, and taught philosophy and divinity in several colleges, but devoted his time chiefly to the study of the Holy Scriptures. That he might render this study the more easy, he made himself master of the oriental languages. Of his writings we have, 1. Commentaries upon the book of Job, two vols. in folio; 2. Commentaries upon Ecclesiastes; 3. A general History of the Church, in Spanish, four vols. in folio; and, 4. A History of Ferdinand III. in the same language, in folio. He died in 1637, much regretted by the members of his society, and by the public in general.

PINEROLO, one of the provinces into which the continental part of the kingdom of Sardinia, in Italy, is divided. It is bounded on the north and north-west by Susa, on the east by Turin, on the south by Saluzzo, and on the west by France. It extends over 550 square miles, and contains one city, forty-six towns and villages, with 125,000 inhabitants. A portion of the Cottian Alps is comprehended in this province, in which are found the four valleys of Lucerna, Perosa, San Martino, and Pragelato, which were inhabited by the Waldenses. The district is well watered by several streams, the principal of which, the Clusone, receives the other river. Though for the most part mountainous, the valleys are productive, and there is sufficient corn raised for the consumption of the inhabitants, whilst silk, chestnuts, and turpentine serve the purpose of exchange for the few foreign commodities that are needed. The capital of the province is the city of the same name. It is situated at the foot of the Alps, and is the see of a bishop, whose sumptuous cathedral, with six monasteries and five nunneries, are the most distinguished objects. It contains 11,500 inhabitants, who spin wool and silk, manufacture goods of both materials, and trade also in corn, wine, cattle, and charcoal. It was formerly the residence of the Dukes of Savoy, most of whom were buried in it. Long. 7. 8. E. Lat. 44. 53. N.

PINES, ISLAND OF, in the South Pacific Ocean, near the southern point of New Caledonia. It is about eighteen leagues in circumference. Long. 167. 32. E. Lat. 22. 38. S.

PINET, ANTONY DU, an ecclesiastical writer, who lived in the sixteenth century, and was a native of Besançon, in France. He was strongly attached to the Protestant religion, and a bitter enemy to the church of Rome. His book, entitled La Conformité des Eglises Reformées de France et de l'Eglise Primitive, printed at Lyons, 1564, in 8vo, and the notes which he added to the French translation of the Fees of the Pope's Chancery, which was printed at Lyons in 8vo, 1564, and reprinted at Amsterdam in 1700, in 12mo, plainly discover his sentiments. The last-mentioned work he published under the title of La Boutique du Pape, in Latin and French, with some notes taken from decrees, councils, and canons, in order to ascertain the discipline anciently observed in the church. In the epistle dedicatory he assumes the tone of a declared enemy of the court of Rome. His translation of Pliny's Natural History, printed at Lyons in two vols. folio, 1566, and at Paris, 1608, was formerly much read. Though it contains many errors, it is nevertheless very useful, especially for those who do not understand the Latin, on account of the translator's researches, and a great number of marginal notes. Pinet also published at Lyons, 1564, in folio, Plans of the principal Fortresses in the World.

PING-LIANG, a city of China, of the first rank, in Shensee, in a fruitful and well-watered district. Long. 106. 18. E. Lat. 35. 35. N.

PINGLO, a city of China, of the first rank, in the province of Quangsee, situated amongst mountains, and on a river which is scarcely navigable from the number of waterfalls which interrupt its course. Long. 110. 4. E. Lat. 24. 22. N.

PINION, in *Mechanics*, an arbor or spindle, having in the body of it several notches, which catch the teeth of a wheel that serves to turn it round; or it is a lesser wheel that plays in the teeth of a larger.

PINNACE, a small vessel navigated with oars and sails, and having generally two masts, which are rigged like those of a schooner.

PINNACLE, in *Architecture*, the top or roof of a house, terminating in a point. This kind of roof amongst the ancients was appropriated to temples; their ordinary roofs being all flat, or made in the platform fashion.

PINOS, an island of the Atlantic, situated near the south coast of Cuba, from which it is separated by a channel sixteen leagues in length by six in breadth. It abounds in pastures, which are covered with herds of goats and other animals; and it is likewise noted for the size of its trees. Although Pinos possesses several very secure and well-sheltered roads, and is of tolerable size, being forty-two miles in length and thirty-four in breadth, yet it is only inhabited by a few fishermen. Long. 82. 45. W. Lat. 21. 38. N.

PINSK, a city of Russia, in the government of Minsk, the capital of a circle of its own name. It is situated on the river Pina, surrounded with deep morasses, and is built in the style of all the old Polish towns. It contains several Greek and Catholic churches, and had a very large collegiate establishment of the Jesuits. It contains 4500 inhabitants, of whom many are Jews, and carries on a considerable trade in the finest red leather. It is 767 miles from St Petersburg. Long. 25. 45. E. Lat. 52. 8. N.

PINTOR, PETER, a physician, was born at Valentia in Spain, in the year 1420, and became physician to Alexander VI. whom he followed to Rome, where he practised with great success. He left behind him two works of considerable merit; 1. Aggregator Sententiarum Doctorum de Curatione in Pestilentia, printed at Rome in 1499, folio; and, 2. De Morbo Fœdo et Occulto his Temporibus Affligenti, printed at Rome in 1500, 4to, black letter, a book extremely scarce, and which traces the *lues venerea* to the year 1496. Pintor died at Rome in the year 1503, aged eighty-three.

PINUS, the PINE-TREE, was one well known to the ancients, and has been described and celebrated both by their philosophers and their poets. Pliny enumerates no less than six species of trees of this genus; and it is mentioned by Virgil in his Eclogues, his Georgics, and his Æneid; by Horace in his Odes, by Ovid in his Metamorphoses, by Statius, and by Catullus.

There are generally reckoned fourteen species of this genus, of which the most remarkable are the following:—

1. The *pinea*, *pineaster*, or wild pine, which grows naturally on the mountains in Italy and the south of France. It grows to the size of a large tree; the branches extend to a considerable distance; and whilst the trees are young, they are fully garnished with leaves, especially where they are not so close as to exclude the air from those within; but as they advance in age, the branches appear naked, and

all those which are situated below become unsightly in a few years; for which reason they are now much less esteemed than formerly.

2. The *pinus pinea*, or stone pine, is a tall evergreen tree, a native of Italy and Spain. It delights in a sandy loam, although, like most others, it will grow well in almost any land. Respecting the uses of this species, Hanbury tells us that the kernels are eatable, and by many prefer-red to almonds.

3. The *rubra*, commonly called the *Scotch fir* or *pine*, is common throughout Scotland, whence its name; though it is also found in most of the other countries of Europe. M. Duhamel mentions his having received some seeds of it from St Domingo in the West Indies; and thence concludes, that it grows indifferently in the temperate, frigid, and torrid zones. The wood of this tree is the red or yellow deal, which is the most durable of any of the kinds yet known

4. The *pinus picea*, or yew-leaved fir, is a tall evergreen, and a native of Scotland, Sweden, and Germany. This species includes the silver fir and the balm of Gilead fir. The first of these is a noble upright tree. The balm of Gilead fir has of all the sorts been most coveted, on account of the great fragrance of its leaves; though this is not its only good property; for it is a very beautiful tree, naturally of an upright growth, and the branches are so ornamented with their balmy leaves, as to exceed any of the other sorts in beauty. The silver fir is very hardy, and will grow in any soil or situation; but it always makes the greatest progress in rich loamy earth. The balm of Gilead fir must be planted in deep, rich, good earth; nor will it live long in any other. The soil may be a black mould, or of a sandy nature, if it be deep enough, and if the roots have room enough to strike freely.

5. The *pinus abies*, or European spruce fir, a native of the northern parts of Europe and of Asia, includes the Norway spruce and long-coned Cornish fir. The former of these is a tree of as much beauty whilst growing, as its timber is valuable when propagated on that account.

6. The *pinus Canadensis*, or American and Newfoundland spruce fir, a native of Canada, Pennsylvania, and other parts of North America, includes three varieties; the white Newfoundland spruce, the red Newfoundland spruce, and the black Newfoundland spruce. These, however, differ so little, that one description may serve for them all. They are of an upright growth, though they do not shoot so freely or grow so fast with us as the Norway spruce. The leaves are of the same green, and garnish the branches in the same beautiful manner, as those of that species; only they are narrower, shorter, and stand closer. The greatest difference is observable in the cones; for these are no more than about an inch in length, and the scales are closely placed. In the cones, indeed, consists the difference of these three sorts; those of the white species are of a very light brown colour, those of the red species more of a nut-brown or reddish colour, and those of the black species of a dark or blackish colour.

7. The *pinus balsamea*, or hemlock fir, a native of Virginia and Canada, possesses as little beauty as any of the fir tribe; though, being rather scarce in proportion, it is deemed valuable. It is called by some the *yew-leaved fir*, from the resemblance of the leaves to those of the yew-tree. It is a tree of low growth, with but few branches; and these are long and slender, spreading abroad without order.

8. The *pinus orientalis*, or oriental fir, a native of the East, is a low but elegant tree. The leaves are very short, and nearly square. The fruit is exceedingly small, and hangs downward; and the whole tree makes an agreeable variety with the other kinds.

9. The *strobus*, or North American white pine. This grows sometimes to the height of a hundred feet and upwards, and is highly valued on account of its beauty. The bark of the tree is very smooth and delicate, especially when young; the leaves are long and slender, five growing out of one sheath; and the branches are pretty closely garnished with them, thus making a fine appearance.

10. The *pinus tæda*, or swamp-pine, is a tall evergreen tree, being a native of the swamps of Virginia and Canada. There are several varieties of this genus.

11. The *pinus cedrus*, ranked by Tournefort and others under *larix*, and famous for its duration, is that popularly called by us the *cedar of Lebanon*, by the ancients *cedrus magna* or the *great cedar;* also *cedrelate*, κεδρελατη; and sometimes the Phœnician or Syrian cedar, from the country where it grows in its greatest perfection. It is a coniferous evergreen, of the larger sort, bearing roundish cones of smooth scales, standing erect, the leaves being small, narrow, and thickly set. They sometimes counterfeit cedar by dyeing wood of a reddish hue; but the smell discovers the cheat, that of true cedar being very aromatic. In some places the wood of the cajou tree passes under the name of cedar, on account of its reddish colour and its aromatic smell, which somewhat resemble those of sandal. Cedar-wood is reputed almost immortal and incorruptible; a prerogative which it owes chiefly to its bitter taste, which the worms cannot endure. For this reason it was that the ancients used cedar tablets to write upon, especially for things of importance, as appears from the expression of Persius, *Et cedra digna locutus.* A juice alluded to by Horace was also drawn from cedar, with which the ancients smeared their books and writings, or other matters, to preserve them from rotting; and by means of which it was that Numa's books, written on papyrus, were preserved entire to the year 535, as we are informed by Pliny.

Solomon's temple, as well as his palace, were both constructed with this wood. That prince gave Hiram, king of Tyre, several cities for the cedars he had furnished on these occasions. Cortes is said to have erected a palace at Mexico, in which were 7000 beams of cedar, most of them 120 feet in length and twelve feet in circumference, as we are informed by Herrera. Some tell us of a cedar felled in Cyprus 130 feet in length and eighteen in diameter. It was used for the mainmast in the galley of King Demetrius. Le Bruyn assures us, that the two largest he saw upon Mount Lebanon measured, one of them fifty-seven palms, and the other forty-seven, in circumference. In the temple of Apollo at Utica there were cedar-trees near two thousand years old; which yet were nothing to the beam in an oratory of Diana at Saguntum in Spain, said to have been brought thither two hundred years before the destruction of Troy. Cedar is of so dry a nature that it will not endure to be fastened with iron nails, from which it usually shrinks; so that they commonly fasten it with pins of the same wood.

It is remarkable that, as far as has yet been discovered, this tree is not to be found as a native in any other part of the world than Mount Libanus. What we find mentioned in Scripture of the lofty cedars can be nowise applicable to the common growth of this tree; since, from the experience we have of those now growing in England, as also from the testimony of several travellers who have visited the few trees remaining on Mount Libanus, they are not inclined to grow very lofty, but, on the contrary, extend their branches very far; a circumstance with which the allusion made by the Psalmist agrees very well, when, describing the flourishing state of the people, he says, "They shall spread their branches like the cedar-tree."

12. There is another species, namely, the *larch-tree*, which the old botanists ranked under *larix*, with deciduous leaves and oval obtuse cones. It grows naturally upon the Alps and Apennines, and of late has been very much propagated in Britain. See PLANTATION.

PIOMBINO, an ancient principality in Italy, now one of the provinces of the grand duchy of Tuscany. It is 136 square miles in extent, and contains one city and eleven villages, with 13,900 inhabitants. The princely house, though mediatized, continues to hold the proprietorship, as before 1815. It is a marshy and very unhealthy tract of country. The capital is the city of the same name, situated on the Bay of Fullonica. It is slightly fortified towards the sea only, and contains 1200 inhabitants, mostly occupied in the fisheries. Long. 10. 25. 42. E. Lat. 42. 55. 27. N.

PIONEERS, in the art of war, are persons who are ordered in from the country, to march with an army, for the purpose of mending the roads, working on intrenchments and fortifications, and forming mines and approaches.

PIOVE di Sacco, a town of Austrian Italy, in the province of Milan and delegation of Padua. It is situated on the Canal of Fiumecello, and contains 790 houses, and 5640 inhabitants, engaged in making silk goods and tanning leather. Long. 11. 57. 11. E. Lat. 45. 17. 21. N.

PIP, or Pep, a disease amongst poultry, consisting of a white thin skin or film, which grows under the tip of the tongue, and hinders their feeding. It usually arises from want of water, or from drinking puddle-water, and eating filthy meat. It is cured by pulling off the film with the fingers, and rubbing the tongue with salt. Hawks are particularly liable to this disease, from their feeding on stinking flesh.

PIPE, a musical instrument, various in kind. (See the articles Music and Organ.) Without entering into useless details regarding the ancient ἄυλοι and *tibiæ*, we may mention that Strutt, in his Sports and Pastimes of the People of England, gives representations of the pipe and tabor, as used in England in the fourteenth century to accompany a dancing dog, a cock on stilts, a horse rearing, &c. From the drawings we cannot ascertain the nature of the pipe represented. We may, however, suppose it to have been similar to the *galoubet* used in France, along with the tabor, from a very remote period. This *galoubet* is a small instrument of the flageolet kind. Its use, for more than the last two centuries, has been confined to Provence. It has only three finger-holes, and is played with the left hand, whilst the right beats the tabor, which is attached to the performer. The compass of the *galoubet* is two octaves and a tone from D on the third line of the treble clef up to E in *altissimo*. Great skill is required to bring out all the sounds of its compass. Some of the players on this small and imperfect instrument are said to be so dexterous as to be able to perform upon it very difficult pieces of music composed for other instruments, such as the violin, &c. It is always accompanied by the tabor, which is a small drum of a cylindrical form, and rather longer and narrower in its relative proportions than the common drum.

Pipe, in building and other employments or arts, a canal, or conduit, for the conveyance of water and other liquids. Pipes for water, water-engines, and the like, are usually of lead, iron, earth, or wood; the latter being usually made of oak or elder. Those of iron are cast in forges, and their usual length is about two feet and a half; several of these being commonly fastened together by means of four screws at each end, with leather or old hat between them to stop the water. Those of earth are made by the potters, and are fitted into one another, one end being always made wider than the other. To join them the closer, and prevent their breaking, they are covered with tow and pitch; their length being usually about that of the iron pipes. The wooden pipes are trees bored with large iron augres, of different sizes, beginning with a less, and then proceeding with a larger successively; the first being pointed, the rest being formed like spoons, increasing in diameter from one to six inches and more. See Boring.

Pipe, *Pipa*, in *Law*, is a roll in the exchequer, called also the *great roll.*

Pipe-Office is an office in which a person, called the *clerk of the pipe*, makes out leases of crown-lands, by warrant from the lord-treasurer, or commissioners of the treasury, or the chancellor of the exchequer. The clerk of the pipe also makes out all accounts of sheriffs, &c. and gives the accountants their *quietus est.*

Piper, *Pepper*, a genus of plants belonging to the *diandria* class. There are twenty species of *piper*, of which the most remarkable is the *siriboa*, with oval, heart-shaped, nerved leaves, and reflexed spikes. This is the plant which produces the pepper so much used in food. It is a shrub, the root of which is small, fibrous, and flexible; and it rises into a stem, which requires a tree or prop to support it. Its wood has the same sort of knots as the vine; and when it is dry, it exactly resembles the vine-branch. The leaves, which have a strong smell and a pungent taste, are of an oval shape; but they diminish towards the extremity, and terminate in a point. From the flower-buds, which are white, and are sometimes placed in the middle and sometimes at the extremity of the branches, are produced small berries resembling those of the currant-tree. Each of these contains between twenty and thirty corns of pepper. They are commonly gathered in October, and exposed to the sun seven or eight days. The fruit, which was green at first, and afterwards red, when stripped of its covering assumes the appearance it has when we see it. The largest, heaviest, and least shrivelled, is the best.

The pepper plant flourishes in the islands of Java, Sumatra, and Ceylon, and more particularly on the Malabar coast. It is not sown, but planted; and great nicety is required in the choice of the shoots. It produces no fruit until the end of three years; but bears so plentifully the three succeeding years, that some plants yield between six and seven pounds of pepper. The bark then begins to shrink; and the shrub declines so fast that in twelve years' time it ceases bearing.

The culture of pepper is not difficult. It is sufficient to plant it in a rich soil, and carefully to pull up the weeds that grow in great abundance round its roots, especially the first three years. As the sun is highly necessary to the growth of the pepper plant, when it is ready to bear, the trees that support it must be lopped, to prevent their shade from injuring the fruit. When the season is over, it is proper to crop the head of the plant. Without this precaution there would be too much wood, and little fruit.

The *piper amalago*, or black pepper, and the *piper inequale*, or long pepper of Jamaica, with some other species, are indigenous, and known by the names of *joint-wood*, or *peppery elders*. The first bears a small spike, on which are attached a number of small seeds of the size of mustard. The whole of the plant has the exact taste of the East India black pepper. The long-pepper bush grows taller than the amalago. The leaves are broad, smooth, and shining; and the fruit is similar to the long pepper of the shops, but smaller. The common people in Jamaica season their messes with the black pepper. To preserve both, the fruit may be slightly scalded when green, then dried, and wrapped in paper.

PIPERS, a musical term, now applied to performers on the bagpipe. Thus we have Northumbrian pipers, Irish pipers, Calabrian pipers, Scottish pipers, &c. The bagpipe seems to be one of the most ancient of musical instruments. It had various names in ancient times and in different countries. Boccacio introduces it as a fashionable instrument in his Decameron; and, from the accounts of the household expenses of our British monarchs, we find that the bagpiper was a court-musician in the olden time. In Strutt's Sports and Pastimes of the People of England, we find a bagpipe player on stilts, from an illuminated manuscript of the thirteenth century, in the reign of Henry III.; and another bagpiper of the same century, with a girl dancing upon his shoulders. Some of the most curious representations of bagpipers and their instruments (*chori* or *cori*) are given by Gerbert *De Cantu et Musica Sacra*, plates thirty-three and thirty-four of the second volume.

PIPLEY, a small town of Hindustan, in the province of Orissa and district of Mohurbunge. It is situated on the eastern bank of the Subanreeka River, about ten miles from the sea. It was with this port, which was considered one of the best in Bengal, that the English were permitted to trade by Shah Jehan; but the trade was afterwards transferred to the Hooghly River. The floods have now washed away part of the town, and formed a dangerous bar in the river, in consequence of which the merchants have removed to Ballasore. Pipley is twenty-two miles north-east from Ballasore. Long. 87. 25. E. Lat. 21. 42. N.

PIPLEY, a town in the province of Orissa and district of Cuttack, thirty miles south from Cuttack. Long. 86. 8. E. Lat. 20. 8. N.

PIPLOUD, a town and large mud fort of the Mahratta territories, in the province of Khandesh, thirty-one miles north-east from Boorhanpoor. Long. 76. 35. E. Lat. 21. 44. N.

PIQUET, or PICKET, a celebrated game at cards, much in use throughout the polite world. It is played between two persons, with only thirty-two cards; the deuces, threes, fours, fives, and sixes, being set aside.

In reckoning at this game, every card goes for the number it bears, as a ten for ten, only all court cards go for ten, and the ace for eleven; and the usual game is one hundred up. In playing, the ace wins the king, the king the queen, and so down.

Twelve cards are dealt round, usually by two and two; which done, the remainder are laid in the middle. If one of the gamesters finds he has not a court card in his hand, he is to declare he has *carte-blanche*, and tell how many cards he will lay out, and desire the other to discard, that he may show his game, and satisfy his antagonist that the carte-blanche is real; for which he reckons ten.

Each person discards, or lays aside a certain number of his cards, and takes in a like number from the stock. The first of the eight cards may take three, four, or five; the dealer all the remainder, if he pleases. After discarding, the eldest hand examines what suite he has most cards of; and reckoning how many points he has in that suite, if the other have not so many in that or any other suite, he tells one for every ten of that suite. He who thus reckons most is said to win the point.

The point being over, each examines what *sequences* he has of the same suite, that is, how many tierces, or sequences of threes, quartes or fours, quintes or fives, sixiemes or sixes, and so on. For a tierce they reckon three points, for a quarte four, for a quinte fifteen, for a sixieme sixteen, and so forth. And the several sequences are distinguished in dignity by the cards they begin from. Thus ace, king, and queen are called *tierce major;* king, queen, and knave, *tierce to a king;* knave, ten, and nine, *tierce to a knave*, &c.; and the best tierce, quarte, or quinte, in other words, that which takes its descent from the best card, prevails, so as to make all the others in that hand good, and destroy all those in the other hand. In like manner, a quarte in one hand sets aside a tierce in the other.

The sequences being over, the players proceed to examine how many aces, kings, queens, knaves, and tens, each holds, reckoning for every three of any sort, three; but here, too, as in sequences, he that with the same number of threes has one that is higher than any the other has, for instance, three aces, has all his others made good thereby, and his adversary's all set aside. But four of any sort, which is called a *quatorze*, always sets aside three.

All the game in hand being thus reckoned, the eldest proceeds to play, reckoning one for every card he plays above a nine, and the other follows him in the suite; and the highest card of the suite wins the trick. However, unless a trick be won with a card above a nine (except the last trick), nothing is reckoned for it, though the trick serves afterwards towards winning the cards; and he who plays last does not reckon for his cards unless he wins the trick.

The cards being played out, he who has most tricks reckons ten for winning the cards. If they have tricks alike, neither reckons anything. The deal being finished, and each player having marked up his game, they proceed to deal again as before, cutting afresh each time for the deal. If both parties be within a few points of being up, the carte-blanche is the first thing that reckons, then the point, then the sequences, then the quatorzes or threes, then the tenth cards.

He who can reckon thirty in hand by carte-blanche, points, quintes, &c. without playing, before the other has reckoned anything, reckons ninety for them; and this is called a *repique*. If he reckons above thirty, he reckons so many above ninety. If he can make up thirty, part in hand and part play, ere the other has told any thing, he reckons for them sixty. And this is called a *pique;* whence the name of the game. He who wins all the tricks, instead of ten, which is his right for winning the cards, reckons forty; and this is called a *capot*.

Mr Demoivre, who has made this game the object of mathematical investigation, has proposed and solved the following problems. 1. To find at piquet the probability which the dealer has for taking one ace or more in three cards, he having none in his hand. He concludes from his computation, that it is twenty-nine to twenty-eight that the dealer takes one ace or more. 2. To find at piquet the probability which the eldest has of taking an ace or more in five cards, he having no ace in his hand; the answer is two hundred and thirty-two to ninety-one, or five to two nearly. 3. To find at piquet the probability which the eldest hand has of taking an ace and a king in five cards, he having none in his hand; the answer is, the odds against the eldest hand taking an ace and a king are three hundred and thirty-one to three hundred and fifteen, or twenty-one to twenty nearly. 4. To find at piquet the probability of having twelve cards dealt to, without king, queen, or knaves, which case is commonly called *cartes-blanches;* the odds against cartes-blanches are seventeen hundred and ninety-one to one nearly. 5. To find how many different sets, essentially different from one another, one may have at piquet before taking in; the answer is, 28,967,278. This number falls short of the sum of all the distinct combinations, by which twelve cards may be taken out of thirty-two, this number being 225,792,840; but it must be considered that in that number several sets of the same import, but differing in suite, might be taken, which would not introduce an essential difference amongst the sets.

PIRÆUS PORTUS, in *Ancient Geography*, a celebrated port to the west of Athens, consisting naturally of three harbours or basins, which lay neglected till Themistocles put the Athenians on making it a commodious port; the Phalerus, a small port, and not far from the city, being what they used before that time.

The Piræus, as Athens flourished, became the common emporium of all Greece. Hippodamus, an architect, celebrated as the inventor of many improvements in housebuilding, besides other monuments of his genius, was employed to lay out the ground. Five porticoes, which, communicating with one another, formed the *Long Portico*, were erected by the ports. Here was an *agora* or market-place, and, farther from the sea, another called *hippoda-*

mia. Beside the vessels were dwellings for the mariners. A theatre was opened, temples were raised, and the Piræus, which surpassed the city in utility, began to equal it in dignity. The cavities and windings of Munychia, natural and artificial, were filled with houses; and the whole settlement, comprehending Phalerus and the ports of the Piræus, with the arsenals, the storehouses, the famous armoury of which Philo was the architect, and the sheds for three hundred, and afterwards four hundred, triremes, resembled the city of Rhodes, which had been planned by the same Hippodamus. The ports, on the commencement of the Peloponnesian war, were secured with chains. Centinels were stationed, and the Piræus was carefully guarded.

The Piræus was reduced with great difficulty by Sylla, who demolished the walls, and set fire to the armoury and the arsenals. In the civil war it was in a defenceless condition. Calenus, lieutenant of Cæsar, seized it, invested Athens, and ravaged the territory of the state. Strabo, who lived under the Emperors Augustus and Tiberius, observes, that the many wars had destroyed the long walls, with the fortress of Munychia, and had contracted the Piræus into a small settlement by the ports and the temple of Jupiter Saviour. See Athens.

PIRANO, a city of the Austrian government of Trieste, in the district of Capo d'Istria. It stands on a tongue of land in the Bay of Trieste, and contains 895 houses, with 6800 inhabitants, who are chiefly employed in the fisheries, or in making salt on the lagunes in their vicinity. Long. 13. 29. 4. E. Lat. 45. 29. 22. N.

PIRATE, πειρατης, a sea-robber, or an armed ship which roams the seas without any legal commission, and seizes or plunders every vessel she meets indiscriminately, whether friends or enemies.

PIRHALA, a town of Hindustan, in Lahore, tributary to the Afghan sovereigns of Caubul. It lies fifty-five miles east from the Indus. Long. 71. 48. E. Lat. 32. 25. N.

PIRNA, a city of the kingdom of Saxony, in the circle of Meissen, and the capital of a bailiwick of its own name, which comprehends eleven cities and towns, and 170 villages, with 36,250 inhabitants. The city is situated upon the banks of the Elbe, is surrounded with walls, and contains three churches, an orphan-house, an hospital, and 500 houses, with about 6000 inhabitants. It suffered much in the campaign of 1813, when it was the centre of the operations between the French and the allied armies; but it rapidly recovered, and is now the seat of considerable manufactures of cotton goods, and has a good trade on the river Elbe, both in building vessels and in conveying goods. A little above the city is the fine castle of Sonnenstein, now occupied as a lunatic asylum.

PIROMALLI, Paul, a Dominican of Calabria, was sent as a missionary to the East. He remained a long time in Armenia, where he had the happiness to bring back to the church many schismatics and Eutychians, and even the patriarch himself, who had before thrown every obstacle in his way. He afterwards passed into Georgia and Persia, then into Poland, in quality of nuncio to Pope Urban VIII., in order to appease the disturbances which had been occasioned there by the disputes of the Armenians, who were very numerous in that country. Piromalli united them in the profession of the same faith, and the observance of the same ceremonies. On his return to Italy he was taken by some corsairs, who carried him prisoner to Tunis. As soon as he was ransomed he went to Rome, and gave an account of his mission to the pope, who conferred upon him some signal marks of his esteem. His holiness intrusted him with the revisal of an Armenian bible, and sent him again into the East, where he was promoted, in 1655, to the bishopric of Nashirvan. After having governed that church for nine years, he returned to Italy, and took charge of the church of Bassignano, where he died three years afterwards, in 1667. His charity, zeal, and other virtues, did honour to the episcopal office. There are extant of his writings, 1. Some works of Controversy and Theology; 2. Two Dictionaries, the one a Latin-Persian, and the other an Armenian-Latin; 3. An Armenian Grammar; and, 4. A Directory, which is of great use in correcting Armenian books.

PIRON, Alexis, a French poet, was born at Dijon in July 1689, where his father was an apothecary, and where he passed more than thirty years in idle and destructive dissipation. He was at length obliged to quit the place of his nativity, in order to avoid the reproaches of his fellow-citizens, on account of an ode which he had written, and which gave them great offence. His relations not being able to give him much assistance, he supported himself at Paris by means of his pen, the strokes of which were as beautiful and fair as those of an engraver. He lived in the house of M. de Belleisle as his secretary, and afterwards with a financier, who, however, did not know that he had a man of genius under his roof. His reputation as a writer commenced with some pieces which he published for the entertainment of the populace, and which showed strong marks of original invention; but what fully established his character in this way was his comedy entitled *Métromanie*, which was the best that had appeared in France since Regnard's Gamester. This performance, in five acts, well conducted, and replete with genius, wit, and humour, was acted with the greatest success upon the French stage in 1738. Piron, however, had a sufficient stock of self-conceit; and what helped to increase it, and make him fancy himself superior to the most celebrated of his contemporaries, was the circumstance that, on account of his original humour, of which he had an uncommon share, his company was more courted than that of Voltaire, who was otherwise too lively, captious, and crabbed. Piron's mischievous ingenuity was partly the cause which excluded him from the French Academy. "I could not," said he, "make thirty-nine people think as I do, and I could less think as thirty-nine do." He called that celebrated society "les invalides du bel esprit," and yet he often endeavoured to become one of those invalids. He died on the 21st of January 1773, at the age of eighty-three. He had prepared for himself the following characteristic epitaph:

Ci gît Piron, qui ne fut rien,
Pas même académicien.

A collection of his works appeared in 1776, in seven vols. 8vo and nine vols. 12mo. The principal pieces are, The School of Fathers, a comedy acted in 1728 under the title of Ungrateful Sons; Callisthenes, a tragedy, the subject of which is taken from Justin; The Mysterious Lover, a comedy; Gustavus and Ferdinand Cortez, two tragedies, some scenes of which discover an original genius, but the versification neither pleases the ear nor affects the heart; Métromanie, a comedy; The Courses of Tempe, an ingenious pastoral, in which the manners both of the town and country are pleasantly drawn; with some odes, poems, fables, and epigrams. In this last kind of poetry he was very successful, and he may be placed after Marot and Rousseau; but there was no occasion for loading the public with seven volumes of his works. The half of that number might have sufficed; for, excepting Métromanie, Gustavus, the Courses of Tempe, some odes, about twenty epigrams, three or four fables, and some epistles, the rest are but indifferent, and have no claim to any extraordinary merit.

PISA, a portion of Italy, once an independent state, but now one of the provinces of the grand duchy of Tuscany. It forms the north-west portion of that duchy, except a small part of Arovalle, and the whole sea-coast to the cape of the Apennines, which divides it from Maremma. In it is included also the Isle of Elba with its dependencies, and the ancient duchy of Piombino. It extends over 2614 square miles, is divided into three districts, and contains 345,000 inhabitants. The capital is the city of the same name, situated near the mouth of the river Arno, in a marshy and unhealthy district, arising from its being enclosed on all sides by the moisture of Paduli del Lupo, Paduli di Stagno, and of the water of the Serchio. It is surrounded with thick walls, now converted into promenades, for which purpose they are better adapted than for defence. It is the see of an archbishop, whose cathedral and palace are magnificent structures; the tower of the former has attracted much attention, and been called the hanging tower, because it considerably declines from the perpendicular. There is a university, founded in 1309, which at present is resorted to by about 300 students, and has a library of 60,000 volumes. It is frequented by invalids, on account of some warm baths on Monte Giuliano, near the city. Pisa contains 2000 houses, and about 18,000 inhabitants, who make some linen and woollen cloths, some silk goods, with glass, paper, white lead, vitriol, and alabaster articles, but depend mostly on the invalid visitors. Long. 10. 18. 10. E. Lat. 43. 43. 7. N.

PISCADORE or Ponghou Islands, a cluster of small islands in the North Pacific Ocean, in the channel of Formosa, about six leagues from the west coast of that island. According to Pérouse, they are a heap of rocks, which assume all kinds of shapes, and are totally barren, but have a good and sheltered harbour. The Chinese maintain a garrison here. They are situated between the island of Formosa and the port of the island of Emouy, and extend from 23. 10. to 23. 40. N., about twenty-four miles; the westernmost is in 119. 27. E. long.

PISCINA, in *Antiquity*, a large basin in a public place or square, where the Roman youth learned to swim, and which was surrounded with a high wall, to prevent filth from being thrown into it. This word is also used for a lavatory amongst the Turks, placed in the middle court of a mosque or temple, where the Mussulmans wash themselves before they offer their prayers.

PISISTRATUS, the son of Hippocrates, was descended from one of the most illustrious families of Athens, which claimed to derive their origin from Codrus, and through him traced their pedigree to Nestor and the Pylian kings. At the time that he began to take part in the political affairs of his country, there were three factions struggling for power; those of the Lowlands, Highlands, and Coast. Megacles, chief of the great family of the Alcmæonidæ, took the lead of the Coast party, whilst Pisistratus headed the democratical faction of the Highlanders. Solon had tried to calm their passions by the wisdom of his laws, but the contending parties had refused to submit; and when he returned, after an absence of several years, he found much confusion, and everything tending towards a state of anarchy. Pisistratus was determined to secure to himself the chief authority in the government; and by pretending to the people that he was in danger of his life, he obtained a guard for the security of his person, and it was not long before he made himself master of the citadel. He thus became what was afterwards called Tyrant of Athens, B. C. 560; though Herodotus expressly states, that all the laws continued in force, and that the constitutional powers of the magistrates were not in the least restricted. Solon used to say, that were it not for his ambition, there would not be a man better disposed, or a more worthy citizen, in Athens. Though Solon was no doubt deeply mortified that his countrymen were unable to maintain the political constitution which he had formed for them, it does not appear that he broke off all connection with Pisistratus. He took the wiser course of trying to direct his measures for the benefit of his country, and assisted him in the administration of the commonwealth. How long Pisistratus continued to maintain himself in power is not stated, but he was at last driven into exile, by the two parties of Megacles and Lycurgus uniting their strength. A dispute between the victors induced Megacles to propose an accommodation with Pisistratus, upon condition that he should marry his daughter; and this was at once acceded to. A quarrel, however, with Megacles again took place, and Pisistratus was obliged to retire to Eretria in Eubœa. Here he continued to increase his influence, till a favourable opportunity presented itself of regaining his former position. It was in the eleventh year of his second banishment that he returned, when the Athenians flocked to his standard, and, in the words of Herodotus, preferred tyranny to liberty. He defeated the Alcmæonidæ, and entered Athens, promising safety to all who returned quietly to their homes. Some of the leaders were of course banished, but the great body of the people seem to have benefited by the change. He was kind to the poor, and introduced many laws and regulations which were highly advantageous to his country. He was a lover of learning, and is said to have been the first who arranged the poems of Homer as we now have them. Cicero speaks of his eloquence in the highest terms. He continued to direct the administration of Athens till his death, B. C. 527, thirty-three years after his first usurpation, of which time he ruled seventeen years. He left two sons, Hippias and Hipparchus, who succeeded to his power.

PISMIRES, or Ants. See Ants.

PISO, Lucius Calpurnius, surnamed the Frugal, on account of his parsimony, was descended of the illustrious family of the Pisos, which gave so many great men to the Roman republic. He was tribune of the people in the year 149 before Christ, and afterwards consul. During his tribuneship he published a law against the crime of concussion or extortion, entitled *Lex Calpurnia de pecuniis repetundis*. He happily ended the war in Sicily. To reward the services of one of his sons, who had distinguished himself in that expedition, he left him by his will a golden crown, weighing twenty pounds. Piso joined to the qualities of a good citizen the talents of a lawyer, an orator, and an historian.

PISSASPHALTUM, or Asphaltum, *Earth-pitch*, a fluid, opaque, mineral body, of a thick consistence, strong smell, readily inflammable, but leaving a residuum of grayish ashes after burning. It arises out of the cracks of the rocks in several parts of the island of Sumatra, and some other places in the East Indies, where it is much esteemed in paralytic disorders. There is a remarkable mine of it in the island of Bua.

PISSELÆUM Indicum, *Barbadoes Tar*, a mineral fluid of the nature of the thicker bitumens, and of all others that which most approaches, in appearance, colour, and consistence, to the true pissasphaltum, though it differs from it in other respects. It frequently occurs in many parts of America, where it is found trickling down the sides of mountains in large quantities, and sometimes floating on the surface of the waters. It has been greatly recommended internally in coughs and other disorders of the breast and lungs.

PISTACIA, Turpentine-tree, *Pistachia-nut* and *Mastich-tree*, a genus of plants belonging to the diœcia class. Pistachia-nuts are moderately large, containing a kernel of a pale greenish colour, covered with a reddish skin. They have a pleasant, sweet, unctuous taste, resembling that of almonds; and they abound with a sweet and well-tasted oil, which they yield in great abundance on being pressed after bruising them. They are reckoned amongst the analeptics, are wholesome and nutritive, and are by some esteemed very proper to be prescribed by way of restoratives, eaten in small quantity, to people emaciated by long illness.

PISTIL, amongst botanists, the little upright column which is generally found in the centre of every flower. According to the Linnæan system, it is the female part of generation, the office of which is to receive and secrete the pollen, and produce the fruit. It consists of three parts; the germen, stylus, and stigma. See Botany.

PISTOJA, a city of the duchy of Tuscany, in Italy, the capital of a district, called a vicariate, of the same name, in the circle of Florence. It stands on the river Ombrone, and is defended by walls and ditches. It is the see of a bishop, whose cathedral is abundantly furnished with holy relics. It contains many churches and monasteries, and 1100 houses, with 9160 inhabitants, who make some woollen cloth, some ironmongery and fire-arms. Long. 10. 32. 45. E. Lat. 45. 47. N.

PISTON, in pump-work, is a short cylinder of metal or other solid substance, fitted exactly to the cavity of the barrel or body of the pump. See Hydrodynamics.

PISUM, Pease, a genus of plants belonging to the diadelphia class. See Horticulture.

PITCAIRNE, Archibald, a physician of great eminence, was born at Edinburgh on the 25th of December 1652. His father, Alexander Pitcairne, who was engaged in trade, and became one of the city magistrates, derived his lineage from the ancient family of Pitcairne of Pitcairne in the county of Fife. His mother, whose name was Sydserf, belonged to a good family in the county of Haddington, descended from Sydserf of Ruthlaw. After having been initiated in classical learning at Dalkeith school, he was sent to the university of Edinburgh in 1668, being then sixteen years of age. In 1671 he took the degree of A. M. It was the wish of his family that he should devote himself to the study of divinity: but for the office of a minister he seems to have had no vocation; and his father, not without some degree of reluctance, permitted him to direct his next views to the profession of law. To this new pursuit he betook himself with all the ardour of a young and ambitious mind; but his intensity of application produced such an effect upon his health, that the physicians, apprehensive of his being visited with consumption, advised him to try the effect of a residence in the south of France.

On his arrival at Paris, he found his health so much improved, that he judged it unnecessary to visit Montpellier; and after having formed some pleasant acquaintances among his young countrymen engaged in the study of physic, he determined to prosecute his own studies without seeking for any other school. They however persuaded him that Paris could not boast of any able professors of law; and he was easily induced to listen to their advice of relinquishing all thoughts of the bar.

> Scire potestates herbarum usumque medendi
> Maluit, et mutas agitare inglorius artes.

After he had for several months attended the hospitals, his father deemed it expedient to recall his wandering footsteps. He accordingly returned to Scotland; and being in this state of preparation for any one of the learned professions, divinity, law, or physic, he continued to enlarge his fund of knowledge, and to cultivate his excellent talents. The mathematical sciences were however his favourite pursuit; and this propensity is supposed to have been fostered by his intimacy with David Gregory, who became professor of mathematics at Edinburgh, and afterwards Savilian professor of astronomy at Oxford. Of his learned friend Dr Gregory, who belonged to a very remarkable family, he has made honourable mention in his works. In this department of study, we are informed, "he made a great progress in a short time; and meeting with the lately invented method of infinite series, he made some improvements thereon, which were afterwards published by Dr Wallis."[1] He is further said to have perceived the necessary connexion between physic and geometry, and thus to have fixed his choice unalterably upon that profession.

He now applied himself to the study of botany, pharmacy, and materia medica, in which branches he could at that time receive no public instruction in Edinburgh. It appears to have been the usual method to attend the private instructions of some established practitioner. In the year 1675 he returned to Paris; and having prosecuted his studies with great ardour and success, he took the degree of M. D. at Reims on the 13th of August 1680. He entered upon his professional career in his native city; and of the Royal College of Physicians, incorporated by a charter bearing date the 29th of November 1681, he was one of the original fellows. His talents and learning were such as could not fail to attract the attention of those among whom he lived. He was a scholar and a wit, as well as a man of science; and he so completely deserted the beaten track of medical speculation, that he was soon regarded as no ordinary character.

After his first settlement in Edinburgh, he married Margaret the daughter of Colonel James Hay of Pitfour. She bore him a son and a daughter; but the mother and her children did not long survive, and he devoted an elegiac poem to her memory. He continued to rise in professional reputation; and this was greatly encreased by the publication of his "Solutio Problematis de Inventoribus," which was printed at Edinburgh in 1688, and again at Leyden in 1693. The object of this tract is to vindicate to Harvey the honour of having discovered the circulation of the blood; an honour of which many attempts had been made to deprive him. According to the notion of Vander Linden, and various other writers, this great fact in the animal economy was known to Hippocrates; but their opinion is very scientifically refuted by Dr Pitcairne. There seems to be much more reason to believe that the unfortunate Servetus "had imperfect glimmerings of that light which afterwards Dr Harvey communicated with so bright a lustre to the learned world."[2]

An attempt to found a medical school in the university had been made in the year 1685. The first professor in that faculty was Sir Robert Sibbald, who was appointed on the 24th of March. Dr Halket and Dr Pitcairne were appointed on the 9th of September; but it has not been ascertained that they read any lectures. Of the estimation in which Pitcairne was held, we find a more striking proof in the circumstance of his being invited by the curators of the university of Leyden to accept a professorship of physic. Of this invitation he did not hesitate to avail himself; and his inaugural oration was delivered on the 26th of April 1692.[3] The oration, we are informed, was highly applauded, and the ordinary salary of his professorship was augmented by one half. We however learn from a passage in Bayle's correspondence, that his lectures were too abstruse, and contained too large an infusion of geometry, to be altogether popular.[4] In this university "he continued little more than a year, during which he read lectures on the works of Bellini, such as were then published. While he was professor here, he printed several dissertations which were drawn from his lectures: in these he attempts to explain the circulation of the blood, and some of the principal parts of the animal œconomy mechanically, as had been done by Bellini, whom he places next to Harvey upon the bench of inventors of physic." Lorenzo Bellini, who was a professor in the university of Pisa, testified his gratitude by dedicating to Pitcairne a collection of his Opuscula.[1] One of his pupils at Leyden was Dr Mead, who always retained the highest regard for his master.

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[1] Biographia Britannica, vol. v. p. 3360.

[2] See Dr Wotton's Reflections upon Ancient and Modern Learning, p. xxiii. 210. 3d edit. Lond. 1705, 8vo.

[3] Archibald Pitcarnii, M. D. et Regii Collegii Medicorum Edinburgensium Socii, Oratio, qua ostenditur Medicinam ab omni Philosophorum Secta esse liberam, habita Lugduni Batavorum die 26 Aprilis CIƆIƆCXCII. cum ordinariam Facultatis Medicæ Praxeosque docendæ Professionem solenniter auspicaretur. Lugd. Bat. 1692, 4to. This oration was reprinted in 1695, and again in 1696. He inserted it in both editions of his Dissertationes Medicæ.

[4] Œuvres Diverses de Bayle, tom. iv. p. 732

Before he quitted Edinburgh, he had made an engagement to marry a daughter of Sir Archibald Stevenson, one of the king's physicians. In the course of the year 1693 he accordingly returned, with the intention of fulfilling his promise, and immediately resuming his academical duties; but the reluctance of the parents to part with their daughter, placed him in a situation of embarrassment, as he was neither disposed to relinquish the professorship nor the young lady. He however adopted the former alternative; and having married Elizabeth Stevenson, he resigned his chair, and finally settled in Edinburgh, where he speedily found himself engaged in very extensive practice. He acquired the reputation of a very skilful practitioner, and indeed his name became more celebrated than that of any other physician then residing in Great Britain. In addition to his more ordinary employment, he received frequent consultations from England, and even from Holland.

With this extensive practice his time was so much occupied, that it did not leave him any abundant leisure for other pursuits. He however continued to gratify his taste by the composition of Latin verses, which were alike calculated to please his friends, and to expose his enemies. His satirical propensities, added to his unrivalled success in a lucrative profession, rendered his enemies somewhat numerous. The violence of his prejudices as a Jacobite and an episcopalian must have had no tendency to recommend him to the best supporters of the existing government. But his friends were likewise numerous; and he pursued his career with great alacrity, and apparently with a great disregard of personal animadversion.

He was fiercely attacked in a little volume, published under the title of "*Apollo Mathematicus;* or the Art of Curing Diseases by the Mathematicks, according to the Principles of Dr Pitcairn: a work both profitable and pleasant, and never published in English before. To which is subjoined a Discourse of Certainty, according to the Principles of the same Author.". Printed in the year 1695, 8vo. This sarcastic work, according to the statement of Dr Oliphant, was the production of Dr, afterwards Sir Edward Eyzat.[2] It was speedily followed by "Tarrugo Unmasked; or an Answer to a late Pamphlet intituled *Apollo Mathematicus*, by George Hepburn, M.D. and Member of the Colledge of Phisicians at Edinburgh. To which is added by Doctor Pitcairne, the Theory of the internal Diseases of the Eye demonstrated mathematically." Edinb. 1695, 4to. This title bears an allusion to "Tarugo's Wiles, or the Coffee-House, a Comedy," written by Thomas Sydserf, or St Serfe, and printed at London in the year 1668. The author of the first tract escaped without any censure from the College of Physicians, of which he was likewise a fellow; but Dr Hepburn, who had been Pitcairne's pupil, and who then resided in Haddington, was not treated with the same degree of forbearance. On the 7th of November a committee was appointed to examine his pamphlet, and on the 3d of December he was suspended from the exercise of his right to sit and vote as a fellow. The proceedings against him appear to have been very arbitrary and irregular: "though a day was allowed him to answer a libel to be given him, and six free days to see it, yet before any libel was given him, or the day of compearance come," they hastened to pass a vote of suspension. During the interval, namely on the 18th of November, Dr Pitcairne had tendered a protest against the admission of certain fellows, one of whom was Eyzat, as having been conducted in an irregular manner. It was then referred to a committee, who on the 22d delivered a report, "that the protestation given in and subscribed by Dr Pitcairn was a calumnious, scandalous, false, and arrogant paper;" and the meeting having unanimously approved of this report, did thereupon suspend him "from voting in the college, or sitting in any meeting thereof." It was even proposed to prohibit him from the practice of physic. At the meeting which suspended Dr Hepburn, four fellows, Melville, Eccles, Oliphant, and Smelholme, were ordered "to compear next day, to hear and see themselves suspended, for adhering to the protestation presented by Dr Pitcairn." The object of all this indecent violence was to deprive them of the right of voting at the ensuing election; "but they having presented a bill of advocation, and obtained a sist for some days, in which the day of election was included, that project was baulked." A double election ensued: Dr Trotter was re-elected president by his adherents, while the opposite party elected Sir Archibald Stevenson. The meeting was attended by one of the bailies; and Pitcairne was removed by the town-officers, after having protested against this unwarrantable interference. He and his friends withdrew to Stevenson's house, and there elected the president and other office-bearers for the ensuing year. These violent animosities produced several applications to the privy council and the court of session. Another fierce contention arose from the question of publishing a Dispensatory, which had been prepared under the sanction of the college. Stevenson's party opposed its publication, on the ground of its being "barely a transcript of the London one, ill copied, and worse explained." Dr Pitcairne was attacked in a virulent pamphlet, which charged him with the inconsistency of having written a commendatory preface to a book which he afterwards represented as worthless.[3] On the 31st of January 1700 an overture towards reconciliation was made to him and other six fellows who had been suspended. Another pacific resolution was passed on the 7th of January 1703; but only three of the seven were disposed to avail themselves of this second opportunity. On the 4th of January 1704 an act of oblivion was proposed by the president, Dr Dundas, and was received with unanimous approbation. It was confirmed at two subsequent meetings, held on the 11th and 12th of the same month. After this period Pitcairne resumed his seat in the college; but after the 6th of March 1706 he was not present at any of their meetings, and was repeatedly fined for non-attendance.[1]

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[1] Laurentii Bellini Opuscula aliquot, ad Archibaldum Pitcarnium, Professorem Lugduno-Batavum, in quibus præcipue agitur de Motu Cordis, &c. Lugd. Bat. 1737, 4to. There are several editions of an earlier date. A long and remarkable dedication, "Viro meritissimo Archibaldo Pitcarnio," is dated at Florence on the 20th of March 1693. It commences thus: "Rapiunt me mores tui, vir meritissime; tua enim illa te gerendi ratio, qua me per literas compellare voluisti, ad omnem optimi et magni viri speciem est ita comparata, ut per universum vitæ meæ spatium vix quicquam mihi contigerit, quod fuerit tam apte factum ad genium meum." In this dedication he introduces Pitcairne's letter, dated at Leyden on the 22d of June 1692.

[2] Oliphant's Short Discourse to prove the Usefulness of Vomiting in Fevers, pref. Edinb. 1699, 8vo. See likewise *Melius Inquirendum*, or, an Answer to Dr Olyphant's Discourse of the Usefulness of Vomiting in Fevers, p. 18. Edinb. 1699, 8vo. Here the authorship of Apollo Mathematicus is not denied by the answerer, who is sufficiently known to have been Dr Eyzat. He is designated in the title of Dr Andrew Brown's Epilogue to the five Papers lately past betwixt the two Physicians, Dr O. and Dr. E. containing some Remarks, pleasant and profitable, concerning the Debate, and the Usefulness of Vomiting and Purging in Fevers. Edinb. 1699, 8vo. He is more directly mentioned in a facetious letter from a London physician, inserted in An Answer to the pretended Refutation of Dr Olyphant's Defence. Edinb. 1699, 8vo. "I have seen the *Melius Inquirendum*, and am too well acquainted with the stile and spelling, not to know that it is Dr Eyzat's."

[3] Information for Dr Archibald Pitcairn, against the abdicate Professor; or, a Mathematical Demonstration that Liars should have good Memories: whereby the Colledge of Physicians is vindicat from the Calumnies contain'd in Dr Stevenson's last Informa-

Other learned bodies had treated him with more respect. On the 7th of August 1699 the university of Aberdeen conferred upon him the degree of M. D. On the 16th of October 1701 the College of Surgeons admitted him a fellow. This last honour, which was unsolicited, had never been bestowed upon any other physician. He was gratified by so unusual a mark of respect, and attended the meetings of the college. He appears to have retained his station as a professor in the university. After the appointment of Carstares to the office of principal, which took place in the year 1703, he was regular in his attendance when the Latin oration was annually delivered at the opening of the session. Between the principal and the professor there was no sympathy of political feeling; but Pitcairne "used to observe that when Mr Carstares began to address his audience, he could not help fancying himself transported to the forum in the days of antient Rome."[2]

Sir Robert Sibbald was one of those who chiefly felt the edge of his sarcastic humour. He was a man considerable for his learning, and is still remembered as an industrious labourer in the department of Scottish antiquities: but he was neither conspicuous for the strength of his judgment nor the elegance of his taste; and with the weapons of wit and sarcasm he was but an unequal match for Dr Pitcairne. He was a member of the committee which prepared so strong a report against the protest; and he incurred the suspicion of having had some concern in the publication of Apollo Mathematicus. In the preface to Dr Hepburn's answer, he is designated in a manner sufficiently intelligible: "Whoever Tarrugo be, yet it's known that the papers which I call Tarrugo's were revised, corrected, and approven by one who twice in one year changed his religion, upon how honest and religious principles, I doe not determine." During the reign of the late popish king, Sibbald had been induced by the earl of Perth, lord chancellor, to change his religion; but having more maturely studied the controversy between the two churches, he returned to the profession of the faith which he had renounced.[3] To this passage of his personal history Pitcairne makes the following allusion:

Dum procul a Geneva se summovet inclyta Roma,
Quod quam sit longum scit Cyphianus iter.

Sibbald, who is thus styled Cyphianus in allusion to his villa of Kipps, was a man of too much candour and moderation to approve of all the violent measures which brought so much discredit on the College of Physicians; and when the president, Dr Sinclair, and only five fellows, had in a very summary manner suspended Stevenson and several others, he concurred with Sir Thomas Burnet in preparing a formal declaration against such unwarrantable proceedings. It is dated on the 20th of November 1699. In the year 1684 he had published a folio volume entitled "Scotia Illustrata, sive Prodromus Historiæ Naturalis." This work was attacked, with sufficient violence, in a tract of nearly a hundred pages, "Archibaldi Pitcarnii Dissertatio de Legibus Historiæ Naturalis." Edinb. 1696, 8vo. As this title includes the author's name at length, it is not easy to explain the origin of Dr Webster's statement that the work was published anonymously. Charges of plagiarism, ignorance, and something little short of stupidity, are plentifully scattered through the dissertation. Nor is the knight of Kipps the only individual who is here subjected to his animadversion: he has likewise bestowed some castigation on Dr Cockburn, of whose treatise on the animal economy he avers, that it contains nothing new but what the author has either borrowed from Bellini or himself, although he has never mentioned the name of the one or of the other. After a long interval appeared "A Letter from Sir R—— S—— to Dr Archibald Pitcairn." Edinb. 1709, 8vo. The author, whoever he may have been, attacks various positions in the medical dissertations of his antagonist. This publication was speedily followed by "A Letter from Dr James Walkinshaw to Sir Robert Sibbald." Lond. 1709, 8vo. The writer's name is known to be supposititious; and, according to a contemporary notice preserved in a copy of the pamphlet, it was understood to be written by Dr Bower with the assistance of Dr Pitcairne. The internal evidence is sufficient to convince us that the other tract was not written by Sibbald, of whose name it exhibits the initials. This answer ascribes it in the most unequivocal terms to Dr Cockburn, of whose reputation as a medical writer it indeed contains a zealous defence. Both tracts include various topics of mathematical controversy. Sibbald at length interfered in the controversy, by publishing "Vindiciæ Scotiæ Illustratæ, sive Prodromi Naturalis Historiæ Scotiæ, contra Prodromomastiges, sub larva Libelli de Legibus Historiæ Naturalis latentes." Edinb. 1710, fol. According to a statement contained in this work, Dr Pitcairne's dissertation had been so carefully suppressed, that for twelve years after its first impression, his antagonist was unable to procure a copy either for love or money. He mentions it as the joint production of several individuals; and moreover avers, what is pointedly denied in a private letter,[4] that Pitcairne disavowed being the author; "nihil unquam a se editum fuisse in meum Historiæ Naturalis Prodromum." If indeed the printed copies were carefully withheld from circulation, he might

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tion, relating to the Dispensatory. Printed in the year 1696, 4to. The writer alludes to a folio paper of six pages, printed for the privy council, under the title of "Information for Sir Archibald Stevinson, and other Physitians who adhere to him, against Doctor Trotter and others."

[1] To the kindness of Richard Poole, M. D. we are indebted for ample materials for the history thofe College of Physicians, so far as it is connected with the personal history of Pitcairne.

[2] Maccormick's Life of Carstares, p. 70. prefixed to his State-Papers. Edinb. 1774, 4to.

[3] Burnet's Hist. of his own Time, vol. iii. p. 108. Cunningham's Hist. of Great Britain, vol. i. p. 66. Fountainhall's Historical Notices, vol. i. p. 220. Autobiography of Sir Robert Sibbald, p. 35. Edinb. 1833, 8vo. On Sibbald's conversion, an English poem of Dr Pitcairne may be found in the Scotish Pasquils, b. iii. p. 62.

[4] This letter accompanied a copy of Sibbald's Vindiciæ, sent to Dr Gray of London: "Sir, you know the bearer: he brings you the rarest piece of lies and nonsense I ever saw. 'Scribit et in tergo, necdum finivit.' The author gave me 3 copies in a compliment, of which I send one to you, and one to Dr Arbuthnot as an answer to his modest examination. The author told me that by my telling him I was not author of the Dissertatio de Legibus Historiæ Naturalis (which he tels indeed, and lyes), he meant, in alledging this upon me, onlie to hinder me from answering him, since he in his Vindiciæ had commended me so much: an excellent reasoning, and which made me smile in place of being angrie. He told me he would let no body else see it till he had got the approbation of all the learned to it. My papers are in the press on the first of this year. Your

"Edr. 6 Jan. 1711. A. PITCAIRNE."

with a safe conscience aver that he had published no such work. It however suited his adversary's plan to consider this as the work of some person or persons unknown; and that plan he even carried so far as to prefix a parenetic ode, not very poetical, in which the talents of Pitcairne are mentioned in terms of no parcimonious commendation.

Dr Pitcairne had published seven medical dissertations in a separate form; and to these he added another, and collected them into a volume, bearing the title of "Archibaldi Pitcarnii Dissertationes Medicæ." Roterodami, 1701, 4to. The volume, dedicated to Bellini, was inaccurately printed in consequence of the author's distance from the press. Not long afterwards it was assailed in a "Dissertatio de Salute quam ferunt Ægrotantibus Dissertationes Archibaldi Pitcarnii." Edinb. 1702, fol. This anonymous dissertation, it was sufficiently ascertained, was the production of Dr Oliphant, whom he had formerly ranked among his friends. An answer, written in English, was immediately published by some individual, who conceals his name, and exhibits the initials J. J. The author of the dissertation replied without delay, nor did his adversary leave him in possession of the field.[1] This adversary, we are inclined to believe, was Dr Bower. In a letter which Dr Drummond addressed to him soon after the death of Pitcairne, we find the subsequent passage: "I cannot but admire and applaud your steady and constant adherence to him in his greatest difficulties, and in the weakness and infirmities of old age. What excellent things you have done in his defence, are particularly known to me; and if they are as well understood by the learned world, they would certainly set your true merits in a clear light, and eternally recommend your unspotted fidelity and friendship." These expressions are evidently applicable to unavowed services, and they appear too strong to be merely applicable to his pamphlet against Cockburn. The two tracts in controversy with Oliphant bear internal evidence of having been written by a mathematician. On the same occasion, another tract was written by Dr Cheyne, who afterwards rose to great eminence in the profession.[2] He had been a pupil of Pitcairne, of whom he always retained a high admiration; and he now defended his master with a degree of violence, which, at more mature age, he had himself the candour to condemn.[3]

About this period of his life, he was involved in proceedings of a different nature. In a private letter addressed to his friend Dr Gray, a physician in London, he had testified his Jacobitical zeal by giving a highly-coloured and exaggerated statement of some transactions connected with a petition for assembling a parliament. This letter appears to have been intercepted, and to have been transmitted to the crown lawyers, who prosecuted the writer before that anomalous tribunal the privy council, on a charge of "leising making." According to the record, "he falsely represents that the said address for the parliament goes on unanimously throw the whole nation, and that only a few courtiers and presbyterian ministers oppose it, but in vain, and that twice so many have signed since the proclamation anent petitioning as signed it before; and bids him take notice that there is one sent to court with a title different, to beguile the elect of the court, if it were possible; and that all the corporationes and all the gentlemen have signed the address, and himselfe among the rest; and, by Jove, it would produce a nationall and universall ———." This blank, it is subsequently stated, "cannot from such premisses be construed to have a less import then a nationall and universall overturning." On the 25th of January 1700 he appeared before the board, attended by David Dalrymple, David Cunningham, and James Nasmyth, his counsel learned in the law. The lord advocate and solicitor general were likewise present. A petition was presented by the defendant, "acknowledging his fault and folly in writing the letter lybelled upon, and declaring it was in cups, and without any design either against his Majesty or the government, and absolutely submitting to the privy councill." He received a reprimand from the lord chancellor; and having recovered the bond which he had previously given for his peaceable behaviour, and for his appearance, whenever he should be required, before the privy council, under the penalty of two hundred pounds sterling, he escaped from any further consequences of this frivolous prosecution.

In another action he appeared in the character of plaintiff. James Webster, one of the ministers of Edinburgh, and Robert Freebairn, an eminent printer and bookseller, "being accidentally in company of the magistrates, Mr Webster complained that Freebairn in his auctions sold wicked and prohibited books, and particularly Philostratus's life of Apollonius Tyanæus, wherein that vile impostor and magician is equalised, if not preferred to our blessed Saviour and his miracles, and which were greedily bought up by atheists and deists; and Mr Freebairn bidding him condescend, Mr Webster answered, Such as Doctor Pitcairn, who is known to be a professed deist; and for farther proof of it, in that same auction, many striving for that infamous book, one regretted that there were none bidding for the Bible, the doctor scoffingly answered, that it was no wonder it stuck in their hands, for 'verbum Dei manet in æternum:' which was a direct ridiculing the scriptures, and the Christian religion." When the bookseller communicated this information to Pitcairne, he lost no time in bringing an action against Webster before the sheriff, "for the redress of that atrocious injury, as tending to make him odious to all who own a God and revealed religion, and to ruin and break his employment." The action was removed by advocation to the court of session; and on the 18th of July 1712, "the Lords considered this process was managed with much zeal [apparently meaning heat, or animosity], and that Mr Webster was willing to give reasonable satisfaction; therefore, they recommend to the Justice Clerk, ordinary in the cause, to endeavour to settle the parties amicably."[4]

These judicial records furnish sufficient confirmation of the traditionary account, which imputes to Pitcairne the character of a profane jester. Dr Hutcheson has thought proper to supply us with another example of his indecent levity. "Many an orthodox Scotch presbyterian, which sect few accuse of disregard for the holy scriptures, has been put to it to preserve his gravity, upon hearing the application of scripture made by his countryman Dr Pitcairn, as he observed a croud in the streets about a mason, who had fallen along with his scaffold, and was over-whelmed with the ruins of the chimney which he had been building, and which fell immediately after the fall of the poor mason; 'Blessed are the dead which die in the Lord, for they rest from their labours, and their works follow them.'"[1] Such a story as this reflects but little credit on him who made, or who thus repeats the jest. "For the honour of the learned physician's memory," says Dr Beattie, "I hope the story is not true. Such wantonness of impiety, and such barbarity of insult, is no object of laughter, but of horror. And I confess, I should have no good opinion of any presbyterian, or of any person, who could find it difficult to preserve his gravity on hearing it."[2]

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[1] A short Answer to a late Pamphlet against Doctor Pitcairn's Dissertations. By J. J. M.D. Edinb. 1702, 8vo. A Refutation of the Short Answer to the Examination of Dr Pitcairn's Dissertations. Edinb. 1702, 8vo. A Reply to Dr Oliphant's Refutation of the Short Answer, &c. By J. J. M.D. Edinb. 1702, 8vo.

[2] Remarks on two late Pamphlets written by Dr Oliphant, against Dr Pitcairn's Dissertations, and The new Theory of Fevers: wherein, besides an Explication of C. O. and his Interpreters, several other surprising Appearances of Nature are mechanically accounted for. By George Cheyne, M. D. and Fellow of the Royal Society. Edinb. 1702, 8vo. Dr Cheyne's previous work was published without the author's name: "A new Theory of Continu'd Fevers," &c. Edinb. 1701, 8vo.

[3] Cheyne's Essay of Health and long Life, p. vii. 4th edit. Lond. 1725, 8vo.

[4] Fountainhall's Decisions, vol. ii. p. 756.

From these unedifying details, we return to the prosecution of his literary history. His next publication was an ingenious lucubration, bearing the title of "Epistola Archimedis ad Regem Gelonem, Albæ Græcæ reperta anno æræ Christianæ 1688." This tract, consisting of 48 pages in octavo, has no imprint; but a copy belonging to the library of the College of Physicians contains in manuscript, "Amstelodami, typis Georgii Gallet, 1706." After this period he occupied himself with the preparation of a new edition of his dissertations; but before he could finish his task, his health was so much impaired, that he found himself incapable of effecting all that he intended. The edition was however published a few months before his death: "Archibaldi Pitcarnii Scoti Dissertationes Medicæ, quarum multæ nunc primum prodeunt. Subjuncta est Thomæ Boeri, M. D. ad Archibaldum Pitcarnium Epistola, qua respondetur Libello Astrucii Franci." Edinb. 1713, 4to. This volume contains fourteen dissertations. Prefixed is a dedication which the Jacobites must doubtless have construed in their own way: "Deo suo et Principi opus hoc consecrat Archibaldus Pitcarnius Scotus." The author's speculations on the subject of digestion had been controverted by Astruc; and here he receives an elaborate answer from Dr Bower, professor of mathematics in King's College, Aberdeen. The writer was evidently a man of learning, and Pitcairne has mentioned him in terms of particular friendship. The preface to the volume contains an extract of a letter from the second James Gregory, relating to the subject of contraction and compression, as discussed by Astruc. Of these dissertations an English translation was soon afterwards published by Dr Sewell and Dr Desaguliers.[3]

Dr Pitcairne died on Friday the 20th of October 1713, in the sixty-first year of his age. His remains were interred in Greyfriars churchyard, where his monument, a plain stone, was repaired in 1800. By his second wife, who survived till the year 1734, he left a son and four daughters. Before he attained the age of majority, the son engaged in the rebellion of 1715; and having been imprisoned in the Tower, he obtained his release in consequence of Dr Mead's very earnest intercession with Walpole. His letter, which mentions the father in terms of high admiration and gratitude, appears to have been entrusted to the distressed mother. Her son entered into the Dutch service; and, "on account of his own merit, and the memory of his father, he would probably have arrived at great promotion, had he not died soon after."[4] The second daughter, Janet, was married on the 12th of October 1731, to Alexander fifth earl of Kelly. She died on the 7th of June 1775. Two of her sons, Thomas Alexander and Archibald, succeeded to the title. The former was very eminent for his skill in music, and some of his compositions have very recently been published by Mr Sharpe.[5] His youngest brother, Andrew Erskine, was known as a man of wit and literature. All the three died unmarried; and the earldom of Kelly is now conjoined with that of Mar.

Four years after the death of the author, appeared "Archibaldi, Pitcarnii Medici celeberrimi Scoto-Britanni, Elementa Medicinæ physico-mathematica, libris duobus, quorum prior Theoriam, posterior Praxim exhibet, in Medicinæ Studiosorum gratiam delineata. Nunc primum in lucem edita." Lond. 1717, 8vo. Hagæ Com. 1718, 4to. Of the first book the concluding chapter had already been printed at the end of the Praxis Medica Boerhaaveana. The entire volume was "printed from a copy compiled out of the notes that had been taken by some of his pupils, together with some rough draughts taken from his papers, which, as they were never revised by him, he was always very careful to suppress during his life-time." It is therefore evident that this work was produced under very unfavourable circumstances. A collection of all his works in Latin prose, with the addition of a few poems, was afterwards published, under the title of "Archibaldi Pitcarnii, Medici celeberrimi Scoto-Britanni, Opera omnia Medica." Lugd. Bat. 1737, 4to.[6]

A posthumous production of a different class is commonly ascribed to the same learned author: "The Assembly; a Comedy. By a Scots Gentleman." Lond. 1722, 8vo. After an interval of many years, the same drama was again printed, and without any reference to a former edition: "The Assembly; or, Scotch Reformation; a Comedy, as it was acted by the Persons in the Drama. Done from the original manuscript, written in the year 1692." Edinb. 1766, 12mo. This edition contains a long preface, omitted in the first. Of the two editions, the Biographia Dramatica, vol. ii. p. 40, has made two distinct comedies. The preface represents this comedy as the composition of more than one author. "This play was begun just after the king of France took Mons, as is clearly intimated in the first scene; but, by reason of some gentlemens going to the country, who were concerned in it, it lay dormant four months; then it was set about again, and was very soon compleated. We confess it was hastily huddled together; for we were not a fortnight about the whole work, by reason of multitude of business the authors were entangled in." According to this account, Pitcairne is only entitled to a share in the honour or discredit of such a production. It is a rabid effusion of Jacobitism, less remarkable for wit and humour than for ribaldry and profanity. He is likewise supposed to be the author of another work, which has recently been edited by Mr Kinloch: "Babell; a Satirical Poem, on the Proceedings of the General Assembly in the year M.DC.XCII." Edinb. 1830, 4to. The manuscript copies, of which several have been preserved, bear the initials of his name. The poem relates to the same subject as the comedy, and it evinces the same spirit of animosity to the Whigs and presbyterians. The author's rhymes are sufficiently familiar and negligent.

As a writer of Latin verses, he appears to much more advantage. Many of his poems were printed in a fugitive form, but not published by himself. There is however a collection of his "Poemata Selecta," consisting of fourteen pages in folio, but without a date, and without any formal title. An edition was afterwards published by Ruddiman;[1] with whom he had accidentally become acquainted at Laurencekirk, and whom he had liberally encouraged to transfer his residence to Edinburgh. On the death of his friend and benefactor the editor has inserted an elegy, which concludes with this distich:

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[1] Hutcheson's Reflections upon Laughter, and Remarks upon the Fable of the Bees, p. 9. Glasgow, 1750, 12mo.

[2] Beattie's Essay on Laughter and Ludicrous Composition, p. 399.

[3] The whole Works of Dr Archibald Pitcairn, published by himself: wherein are discovered the true Foundation and Principles of the Art of Physic; with Cases and Observations upon most Distempers and Medicines. Done from the Latin original, by George Sewell, M. D. and J. T. Desaguliers, LL. D. & F. R. S. With some account of the author. The second edition. Lond. 1727, 8vo.

[4] Webster's Account of the Life and Writings of Dr Archibald Pitcairne, p. 34. Edinb. 1781, 8vo.

[5] Minuets, &c. composed by the Right Honourable Thomas Earl of Kelly. Edinb. 1836, 4to.

In the Biographie Médicale, tom. vi. p. 428, other editions of Pitcairne's works are mentioned: "Opera omnia. Venise, 1793, in 4o. Leyde, 1797, in 4o."

> Ergo vale, lux Scotigenum, princepsque medentum,
> Musarum columen deliciæque, vale.

The Latin poems of Pitcairne have been extravagantly extolled by some of his countrymen.[2] They are chiefly to be commended for their epigrammatic merit, their point and pungency. Many of his verses are elegantly turned; but they are frequently rendered obscure by his allusions to circumstances of too private a nature to admit of easy explanation, after an interval of more than a century. Some of the allusions are explained by himself, in a curious paper which has recently been printed for the first time; others by Lord Hailes, in an article communicated to a periodical work.[3] This eminent person, whose extensive learning was founded on very accurate and critical scholarship, entertained the design of publishing an edition of Pitcairne's Latin poems, with annotations; and some of the materials which he collected have fortunately been preserved in this form. Several of those poems were written in the name of Walter Danistone, who appears to have been one of the author's friends. His epitaph on Viscount Dundee was translated by Dryden. Another of his poems became very conspicuously known by the easy and elegant paraphrase of Prior, whom Dr Drummond has described as his old comrade. It commences with these verses:

> Studious the busy moments to deceive,
> That fleet between the cradle and the grave,
> I credit what the Grecian dictates say,
> And Samian sounds o'er Scotia's hills convey.[4]

The personal character of Dr Pitcairne has been variously represented. That he was a man of a liberal and benevolent disposition, is sufficiently established by the testimony of his contemporaries. "In the business of his profession," says Dr Sewell, "he was always ready to serve every one to the utmost of his power, and even to contribute to their health at the danger of his own. He was a man of too good sense to be a humourist in physic, or refuse attendance out of pique, or prejudice, or affectation: he understood the value of life too well to sacrifice it to caprice and humour. There is one thing more remarkable of him; that he was not at all concerned about fees, and frighted from his duty by the sight of poverty in his patient; nay, he went with greater chearfulness to those from whom he could expect nothing but good will, than to persons of the highest condition. Besides, in cases which seemed to require that assistance, he not only gave away his skill and medicines, but extended his generosity for the provision of other conveniences for the sick, and left the marks of his charity, as well as of the liberality of his art, behind him. The virtue of charity was really so much his own, in the use of it, that he contrived a most secret and decent manner of conveying his benevolence, and relieved many who knew not their benefactor. In short, he was one of the greatest and most useful men in his profession this age has produced; of a free and universal genius, a good orator, poet, and philosopher. He was of a pleasant, engaging humour. Life sate very easy upon him in all its circumstances. He despised many, but hated none. He loved his friends, and laughed at his enemies." This characteristic account, written in 1715, is confirmed by Dr Drummond, who soon after the death of Pitcairne wrote in the following terms to their mutual friend Dr Bower: "Though he got much money by his extraordinary skill and practice in physic, yet he did not hoard up riches, but dealt liberally to his poor friends and relations, and also gave frankly and generously to young men of good spirits, who were in narrow circumstances. So he was not only a learned man, but a Mæcenas too, and an encourager of learning through the whole course of his life. His great care and commiseration of the poor ought not to be omitted. He not only gave them medicine freely, but money too, for their relief and support; and this kind of charity is one of the best effects of pure and undefiled religion. Besides, he did not spend all his money on his pleasure and freaks, but erected a most noble library, which, for the great variety and excellent collection of books, is one of the finest I have seen belonging to any private man in the kingdom."[5] After his death, his library was purchased by the czar of Muscovy. In his personal habits, he appears to have been somewhat inclined to jovialty. At that period, professional men were more accustomed to frequent taverns than they are at present; and his poems contain various allusions to his social haunts and companions. Of the levity of his conversational wit we have already seen more than one specimen. His profane jests exposed him to the most injurious imputations, and he was very frequently represented as a professed unbeliever. But whatever doubts might be entertained as to the soundness of his creed, they are completely removed by his verses written on Christmas-day; and Dr Drummond has stated that, during his last illness, he continued in the greatest tranquillity of mind, and evinced just apprehensions of God and religion. His political sentiments do not here seem to require much notice. It is not easy to admire the political wisdom or moral perception of a man whose heroes were King James, Viscount Dundee, and Sir George Mackenzie.

As a medical practitioner, he attained to much more extensive and lucrative employment than any former physician resident in Scotland. He left behind him a reputation which was not confined to his native country. He belongs to the mathematical and mechanical school of physic; and, in the annals of medicine, his name is honourably mentioned with those of Borelli, Bellini, and other great masters of the mathematico-medical art.[6] They all contended for the application of mathematical reasoning and demonstration to subjects of anatomy and physiology. John Bernoulli, who belonged to a very distinguished family, not only adopted their method in his treatise *De Motu Musculorum*, but he even maintained in verse the cause of the mathematical physicians.

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[1] Selecta Poemata Archibaldi Pitcarnii, Med. Doctoris, Gulielmi Scot a Thirlestane, Equitis, Thomæ Kincadii, civis Edinburgensis, et aliorum. Edinb. 1727, 12mo. Sir William Scott, Bart. was the ancestor of Lord Napier in the male line. (Wood's Peerage of Scotland, vol. ii. p. 299.) Thomas Kincaid was a surgeon in Edinburgh.

[2] "Ipsum equidem ego existimo ingenti adeo ingenio, et labore non pœnitendo, versus fecisse, ut non verear eum anteferre omnibus lyricis, qui ab Horatii temporibus ad nostrum usque ævum vixere." (Dissertatio de Scriptis Pitcarnianis, auctore Roberto Hepburnio, Scoto, J. C. Lond. 8vo.) The dedication to Joseph Addison is dated at Amsterdam on the 1st of March 1715.

[3] Edinburgh Magazine and Review, vol. i. p. 235.

[4] Prior's Poems on several Occasions, p. 297. Lond. 1718, fol.

[5] Dr Drummond's letter may be found in Mr Kinloch's preface to Babell, p. iv.

[6] See Petri Antonii Michelotti Tridentini de Separatione Fluidorum in Corpore Animali Dissertatio physico-mechanico-medica, p. 13. Venetiis, 1721, 4to.

Nunc eat indoctus, doctoque is suadeat orbi,
Nullam arti medicæ ferre mathesin opem:
Scilicet ut vulpes, caudam quæ amiserat, illa
Ne pudibunda foret syrmate sola carens.
Vestrum, ait, O sociæ, deponite inutile membrum!
Ast abiit salsis exagitata jocis.

Dr Pitcairne seems to have improved both the theory and the practice of physic. He made some advances in completing Harvey's speculations on the circulation of the blood, and in explaining the process of secretion. He laboured with great energy to explode the errors of former writers, who maintained the chemical doctrines of a corrosive menstruum in the stomach, and a certain acidity in the blood that required to be corrected by an alkali. If he relied too much on the aid of mathematics as an instrument of medical science, he at least contributed, by his conspicuous example, to recommend a clear and concise mode of reasoning, to which preceding writers did not usually attain. Boerhaave, the most illustrious of his successors in the chair at Leyden, bestowed very high commendation on his first collection of dissertations;[1] and Dr Mead, whose name stood unrivalled in his own age and nation, evidently regarded his works as exhibiting a model of disquisition in their own department of science.[2] (x.)

PITCH, a tenacious oily substance, drawn chiefly from pines and firs, and used in shipping, medicine, and various arts; or it is more properly tar inspissated by boiling it over a slow fire.

PITCHING, in naval affairs, may be defined the vertical vibration which the length of a ship makes about her centre of gravity; or the movement by which she plunges her head and after-part alternately into the hollow of the sea. This motion may proceed from two causes; the waves which agitate the vessel, and the wind upon the sails, which makes her stoop to every blast. The one depends absolutely upon the agitation of the sea, and is not susceptible of inquiry; the other is occasioned by the inclination of the masts, and may be submitted to certain established maxims.

PITHIVIERS, an arrondissement of the department of the Loiret, in France, extending over 475 square miles. It comprehends five cantons, divided into 108 communes, and contains 56,800 inhabitants. The capital is the city of the same name, situated in a fertile district, watered by the River Deuf. It contains 720 houses, with 3430 inhabitants, who deal largely in wine, brandy, and other products of the surrounding country. Long. 2. 10. 4. E. Lat. 48. 10. 26. N.

PITHO, in fabulous history, the goddess of persuasion amongst the Romans. She was supposed to be the daughter of Mercury and Venus, and was represented with a diadem on her head, to intimate the influence she exercised over the hearts of men. One of her arms appeared raised in the attitude of an orator haranguing a public assembly; and in the other she held a thunderbolt and fetters, made with flowers, to signify the powers of reasoning and the attractions of eloquence. A caduceus, as a symbol of persuasion, appeared at her feet, and beside it were the writings of Demosthenes and Cicero, the two most celebrated orators amongst the ancients.

PITHOU, Peter, a Frenchman of great literary eminence, was descended from an ancient and noble family in Normandy, and born at Troyes in 1539. His taste for literature early showed itself, and his father cultivated it to the utmost. He first studied at Troyes, and was subsequently sent to Paris, where he became the scholar and friend of Turnebus. Having finished his pursuits in languages and the belles lettres, he was removed to Bourges, and placed under Cujacius to study the civil law. His father was well skilled in his profession, and has left a favourable specimen of his judgment in the advice he gave to his son as to the best method of acquiring a knowledge of law; which was, not to spend his time and labour upon commentators, but to confine his reading chiefly to original writers. The latter made so rapid a progress, that at the age of seventeen he was able to speak *extempore* upon the most difficult questions; and his master was not ashamed to own, that even he himself had learned some things of his pupil. Cujacius afterwards removed to Valence, whither Pithou followed him, and continued to profit by his lectures until the year 1560. He then returned to Paris, and frequented the bar of the parliament there, in order to combine a knowledge of practical forms and usages with his theoretical acquisitions.

In 1563, being then only twenty-four, Pithou published his *Adversaria Subcesiva*, a work highly applauded by Turnebus, Lipsius, and other learned men, and which laid the foundation of that extensive fame which he subsequently acquired. Soon after this, Henry III. advanced him to some considerable posts, in which, as well as at the bar, he acquitted himself most creditably. Pithou, being a Calvinist, narrowly escaped being involved in the massacre of St Bartholomew in 1572; for he was in Paris when this tragedy took place, and in the same lodgings with several Huguenots, who were all killed. It seems indeed to have frightened him out of his religion, which he soon afterwards abjured, at the same time openly embracing the Catholic faith. At a subsequent period, he attended the Duke of Montmorency into England; and upon his return, his great sagacity, invincible good nature, and amiable manners, rendered him a kind of oracle to his countrymen, and even to foreigners, who consulted him upon all important occasions. An instance of this we have in the conduct of Ferdinand, the Grand Duke of Tuscany, who not only consulted him, but even submitted to his determination in a point contrary to his interests. Henry III. and Henry IV. were greatly indebted to him for combating the League in the most intrepid manner, and for many other services, in which he had recourse to his pen as well as to other means.

Pithou died upon his birth-day in the year 1596, leaving a wife, whom he had married in 1579, and several children. De Thou says he was the most excellent and accomplished man of the age in which he lived; and all the learned have concurred in speaking well of him. He collected a very valuable library, containing a variety of rare manuscripts, as well as printed books; and he took many precautions, but in vain, to prevent its being dispersed after his death. He published a great number of works upon law, history, and classical literature; and he gave several new and correct editions of ancient writers. He was the first who made the world acquainted with the Fables of Phædrus, which were utterly unknown till they were published from a manuscript in his possession. His numerous works belong to the civil and the canon law, to history, and to literature properly so called. As a jurisconsult, Lefebvre observed of him, "Cujacius discipulo præripuit ne primis jurisconsultus esset; ille præceptori ne solus." He was closely connected in friendship with Cujacius, and, after the death of the latter, he published his master's Observations on the Roman Law, accompanied with Remarks and Annotations of his own. We are also indebted to him for the discovery of the laws of the Visigoths, which he published in 1579.

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[1] "Hæc scripta optima sunt et perfecta, sive legas dissertationem de motu sanguinis per pulmones, sive alia opuscula, sive ultimum tractatum de opio." (Boerhaave Methodus Studii Medici, emaculata et accessionibus locupletata ab Haller, tom. i. p. 569. Amst. 1751, 2 tom. 4to.) Haller describes him as "acris homo et confidens, iatro-mathematicus, Jacobo II. addictissimus." (Bibliotheca Anatomica, tom. i. p. 761. Lugd. Bat. 1774–7, 2 tom. 4to.)

[2] "The Dissertations of Dr Pitcairne, the honour of the profession of Scotland, are a convincing proof of the advantage of such a mechanical way of reasoning; nor could malice itself deny this, were not ignorance in confederacy with it, which will secure any one from being benefited by the most useful demonstrations." (Mead's Mechanical Account of Poisons, p. xvii.)

His principal writings on the canon law are, 1. Corpus Juris Canonici, 1687, in two vols. folio; 2. Codex Canonum vetus ecclesiasticum, in folio; 3. Gallicæ Ecclesiæ in schismate Status, in 8vo; and, 4. A Treatise on the Liberties of the Gallican Church. Pithou also published an edition of the Capitularies, which has since been surpassed by that of Balzuc; a series of French annalists, from the eighth to the thirteenth century; Memoirs of the Counts de Champagne and de Brie; the Historical Fragments of St Hilarius, containing curious particulars respecting the Council of Rimini; and the writings of several ancient doctors of the Gallican Church, of which several had until then remained inedited. We are likewise indebted to him for editions, from the best manuscripts, of several ancient geographers, the Itinerary from Bordeaux to Jerusalem, the works of Salvian, the Declamations of the Roman rhetoricians, Juvenal and Persius, Petronius, and the moral Distichs attributed to Cato. He enriched literature, as already mentioned, with the Fables of Phædrus, the manuscript of which had been discovered by his brother, and also with the *Pervigilium Veneris*, both previously unknown. Lastly, he amused himself with paying court to the Latin muses; but his poetry, like his eloquence, had no other ornament than it derived from the thoughts.

PITISCUS, Samuel, a learned philologist, was born at Zutphen, in Dutch Gueldres, and became rector of the college of that city, and afterwards of St Jerome at Utrecht, where he died on the 1st of February 1717, at the age of ninety. He wrote, 1. Lexicon Latino-Belgicum, 1704, in 4to; 2. Lexicon Antiquitatum Romanarum, in quo ritus et antiquitates, tum Græcis et Romanis communes, tum Romanis particulares exponuntur, Leeuwarden, 1713, in two vols. folio; and he published good editions, with prefaces and notes, of Quintus Curtius, Polyhistor, Solinus, with the Observations of Salmasius on Pliny, Suetonius, Aurelius Victor, the Pantheon Mythicum, and the *Antiquitates Romanæ* of Rosini. In 1685, Pitiscus announced a *Lexicon Catullo-Tibullo-Propertianum;* but this work, which his friends regarded as a mine of erudition, never appeared.

PITKEATHLY, or Pitcaithly, a rural watering-place, much resorted to, in Perthshire.

PITOT, Henry, descended of a noble family of Languedoc, was born at Aramont, in the diocese of Usez, on the 29th of May 1695, and died there on the 27th of December 1771, aged seventy-six. He studied the mathematics without a master, and went to Paris in 1718, where he formed a close friendship with the illustrious Reaumur. In 1724 he was admitted a member of the Royal Academy of Sciences at Paris, and in a few years he rose to the rank of pensioner. Besides a great number of Memoirs printed in the collection of that society, he published in 1731 the Theory of the Working of Ships, in one volume 4to; a work of considerable merit, which was translated into English, and caused the author to be admitted into the Royal Society of London. In the year 1740, the states-general of Languedoc made choice of him as their chief engineer, and at the same time gave him the appointment of inspector-general of the canal which unites the two seas. That province is also indebted to him for several monuments of his genius, which will transmit his name with lustre to posterity. The city of Montpellier being in want of water, Pitot brought from a distance of three leagues the water of two springs, which furnish a plentiful supply of that necessary article. The water is brought to the magnificent Place du Peyron, and thence distributed throughout the city. This work is the admiration of all strangers. The celebrated Marshal de Saxe was the great patron and friend of Pitot, who had taught him the mathematics. In 1754 he was honoured with the order of St Michael. In the year 1735 he married Marie Leonine Pharambier de Sabballoua, descended of a very ancient noble family of Navarre; but by this marriage he had only one son, who became advocate-general of the court of accounts, aids, and finances of Montpellier. Pitot was a practical philosopher, and a man of uncommon probity and candour. He was also a member of the Royal Society of Sciences of Montpellier, before which his eloge was pronounced in 1772, by M. de Ratte, perpetual secretary, in presence of the states of Languedoc; and, in the Royal Academy of Sciences of Paris, the same honour was done him by the Abbé de Fouché, who was then secretary.

PITS, John, the biographer, was born in 1560, at Aulton, in Hampshire, and educated at Wykeham's school, near Winchester, where he remained until he was about eighteen years of age, when he was sent to New College, Oxford, and admitted a probationer fellow. Having continued in that university not quite two years, he left the kingdom as a voluntary exile, and retired to Douay, whence he proceeded to the English college at Rheims, where he remained about a year, and then went to Rome, where he continued a member of the English college nearly seven years, at the expiration of which he was ordained priest. In 1589 he returned to Rheims, where, during two years, he taught rhetoric and the Greek language. He then quitted Rheims on account of the civil war in France, and retired to Pont-à-Mousson, in Lorraine, where he took the degrees of master of arts and bachelor in divinity. From this he travelled into Germany, and resided a year and a half at Triers, where he commenced licentiate in his faculty. He then visited several of the principal cities in Germany, and, continuing three years at Ingoldstadt, in Bavaria, took the degree of doctor in divinity. Having made the tour of Italy, he returned once more to Lorraine, where he was patronised by the cardinal of that duchy, who preferred him to a canonry of Verdun; and about two years afterwards he became confessor to the Duchess of Cleves, daughter of the Duke of Lorraine. During the leisure he enjoyed in this employment, he wrote in Latin the lives of the kings, bishops, apostolical men, and writers of England. The last of these, commonly known and quoted by the title of *De illustribus Angliæ scriptoribus*, was published after his death. The three others still remain in manuscript amongst the archives of the collegiate church of Liverdun. The Duke of Cleves having died about twelve years after Pits had been confessor to the duchess, the latter returned to Lorraine, attended by our author, who was promoted to the deanery of Liverdun, which, with a canonry and officialship, he enjoyed till the close of his life. He died in 1616, and was buried in the collegiate church. Pits was undoubtedly a scholar, and not an inelegant writer; but he is justly accused of ingratitude to Bale, from whom he borrowed his materials, without acknowledgment. He quotes Leland with great familiarity, without ever having seen his book; his errors are innumerable, and his partiality to the Catholic writers is obvious; nevertheless we are indebted to him for his account of several Catholic authors who lived abroad at the beginning of the Reformation.

PITT, Christopher, an English poet, celebrated for his translation of Virgil's Æneid, was born in the year 1699. Having studied four years at New College, Oxford, he was presented to the living of Pimperne, in Dorsetshire, which he held during the remainder of his life. He had so poetical a turn, that whilst he was a school-boy he wrote two large folios of manuscript poems, one of which contained an entire translation of Lucan. He was much esteemed while at the university, particularly by the celebrated Dr Young, who used familiarly to call him his son. Next to his translation of Virgil, Mr Pitt gained the greatest reputation by his excellent English version of Vida's Art of Poetry. This amiable poet died in the year 1748, without leaving, it is said, one enemy behind him.

Pitt, *William*, first Earl of Chatham, a celebrated British statesman and orator, was born on the 15th of November 1708. He was the youngest son of Mr Robert Pitt of Boconnock, in Cornwall, and grandson of Mr Thomas Pitt, governor of Fort St George in the East Indies in the reign of Queen Anne, who sold an extraordinary diamond to the king of France for L.135,000, and thus obtained the name of *Diamond Pitt*. The subject of this notice was educated at Eton, whence, in January 1726, he was removed to Trinity College, Oxford, which he entered as a gentleman commoner. Here the superiority of his mind soon attracted notice, and he was also remarked for his powers of elocution; but, at the age of sixteen, he experienced the first attacks of an hereditary and incurable gout, which continued at intervals to torment him during the remainder of his life. He quitted the university without taking a degree, and visited France and Italy, whence he returned without having received much benefit from his excursion. His father was now dead, and as he had left very little to the younger children, it became necessary that William should choose a profession. He decided for the army, and a cornet's commission was procured for him in the Blues. But, small as his fortune was, his family had the power and the inclination to serve him. At the general election of 1734, his elder brother Thomas was chosen both for Old Sarum and for Oakhampton. When parliament met in 1735, Thomas made his election for Oakhampton, and William was returned for Old Sarum. At the time when he obtained a seat in parliament he was not quite twenty-one years of age. The intention of bringing him thus early into parliament was to oppose Sir Robert Walpole, who had now been fourteen years at the head of affairs. In fact, his abilities soon attracted notice, and he spoke with great vehemence against the Spanish convention in 1738. It was on the occasion of the bill for registering seamen in 1740, which he opposed as arbitrary and unjustifiable, that he is said to have made his celebrated reply to Mr Walpole, who had taunted him on account of his youth; but the language of that reply, as it now stands, is not the diction of Pitt, who may have said something like what is ascribed to him, but of Dr Johnson, who then reported, or rather wrote, the debates for the Gentleman's Magazine. In 1746 Pitt was appointed joint vice-treasurer of Ireland, and in the same year treasurer and paymaster-general of the army, and a privy-councillor. The office of paymaster he discharged with such inflexible integrity, even refusing many of the ordinary perquisites of office, that his bitterest enemies could lay nothing to his charge, and he soon became the darling of the people. At this time he was poor enough; but Heaven directed to him a portion of wealth altogether unexpected. The old Duchess of Marlborough, who carried to the grave the reputation of being decidedly the best hater of her time, and who most cordially detested Walpole and his associates, left him a legacy of L.10,000, in consideration of "the noble defence he had made for the support of the laws of England, and to prevent the ruin of his country." In the year 1755, Mr Pitt, deeming it necessary to offer a strong opposition to the continental connections then formed by the ministry, resigned his places, and remained some time out of office. But his resignation having alarmed the people, he was, in December 1756, called to fill a higher office, and appointed secretary of state. In this situation, however, he was more successful in obtaining the confidence of the public than in conciliating the favour of the king, some of whose predilections he had conceived himself bound to oppose. The consequence was, that soon afterwards Mr Pitt was removed from office, whilst Mr Legge, with some others of his friends, were at the same time dismissed. But the nation had a mind not to be deprived of his services. The most exalted notion had been formed of him throughout the country; his patriotism was believed to be as pure and disinterested as his abilities and eloquence were confessedly transcendent; and his colleagues shared in the same general favour. In a word, the opinion of the country was so strongly expressed, both directly and indirectly, that the king thought it prudent to yield; and, on the 25th of June 1757, Mr Pitt was again appointed secretary of state, Mr Legge became chancellor of the exchequer, and the other arrangements were made conformably to his wishes. Mr Pitt was now in effect prime minister; and the change which soon took place in the aspect of public affairs evinced the ability of his measures, and the vigour of his administration. His spirit animated the whole nation; and his activity pervaded every department of the public service. His plans were ably conceived, and promptly executed; and the depression, which had been occasioned by want of energy in the cabinet, and ill success in the field, was followed by exertion, confidence, and triumph. The whole fortune of the war was changed. In every quarter of the globe success attended our arms. The boldest attempts were made both by land and by sea, and almost every attempt proved fortunate. In America, the French lost Quebec; in Africa, they were deprived of their principal settlements; their power was abridged in the East Indies; in Europe their armies were defeated; and, to render their humiliation more complete, their navy, their commerce, and their finances were almost ruined. Amidst this full tide of success George II. died, on the 25th of October 1760, and was succeeded by George III., who ascended the throne at a time when the French court had just succeeded in obtaining the cooperation of Spain.

The treaty commonly called family compact had been secretly concluded; but the English minister, correctly informed of the hostile intentions of Spain, determined to anticipate that power, and strike a blow before this new enemy should be fully prepared for action. He therefore proposed in the council an immediate declaration of war against Spain; urging forcibly that the present was the favourable moment for humbling the whole house of Bourbon. But when he stated this opinion in the privy council, the other ministers, averse to so bold a measure, opposed the proposition of the premier, alleging the necessity of mature deliberation before declaring war against so powerful a state. Irritated by the unexpected opposition of his colleagues, Pitt replied, "I will not give them leave to think; this is the time, let us crush the whole house of Bourbon. But if the members of this board are of a different opinion, this is the last time I shall ever mix in its councils. I was called into the ministry by the voice of the people, and to them I hold myself answerable for my conduct. I am to thank the ministers of the late king for their support; I have served my country with success; but I will not be responsible for the conduct of the war any longer than while I have the direction of it." To this declaration the president of the council answered, "I find the gentleman is determined to leave us; nor can I say that I am sorry for it, since he would otherwise have certainly compelled us to leave him. But if he is resolved to assume the right of advising his majesty, and directing the operations of the war, to what purpose are we called to this council? When he talks of being responsible to the people, he talks the language of the House of Commons, and forgets that at this board he is responsible only to the king. However, though he may possibly have convinced himself of his infallibility, still it remains that we should be equally convinced before we can resign our understandings to his direction, or join with him in the measure he proposes." The opposition he thus encountered the nation attributed to the growing influence of Lord Bute. But however this may have been, Mr Pitt was a man of too high, not to say imperious a temper, to remain as the nominal head of a cabinet which he was no longer able to direct. Accordingly, on the 5th of October 1761, he resigned all his appointments; and, as some reward for his services, his wife was created Baroness Chatham in her own right, whilst a pension of L.3000 a year was settled on the lives of himself, his lady, and his eldest son.

No fallen minister, if fallen he could be called, ever carried with him more completely the confidence and regret of the nation, whose affairs he had so successfully administered. But at this time the king was also popular; and the war being continued by his new ministers with vigour and success, no discontent appeared until after the conclusion of the peace. The impulse given by Mr Pitt had carried them forward in the same direction which he had pursued; but they were equally incapable of profiting by the advantages which had been already gained, or of prosecuting the war until the objects for which it was originally undertaken should be accomplished. The victories gained over France and Spain having greatly elated the nation, the feeling which almost universally prevailed amongst the people was, that we should either dictate peace as conquerors, or continue the war until our adversaries were more effectually humbled. This was likewise Mr Pitt's opinion. Accordingly, when the preliminaries of peace came to be discussed in parliament, he went down to the House of Commons, though suffering severely from an attack of the gout, and spoke for nearly three hours in the debate; giving his opinion on each article of the treaty in succession, and, upon the whole, maintaining that it was inadequate to the conquests of our arms, and the just expectations of the country. Peace was, however, concluded on the 10th of February 1763, and Mr Pitt continued unemployed.

After his resignation in 1761, Mr Pitt conducted himself in a manner worthy of his high character. So far from giving a vexatious and undiscriminating opposition to the ministry which had succeeded his own, he maintained his popularity in dignified retirement, and came forward only when questions of great importance were to be discussed. One of these occurred in 1764, on the subject of general warrants, the illegality of which he denounced with all the energy and vigour of his eloquence. Another occasion, when he came forward in all his strength, was the consideration of the discontents which had arisen on account of the stamp-act. In March 1766, the repeal of that act having been proposed by the Rockingham ministry, Mr Pitt, though not connected with them, ably supported the measure, which was carried, but whether prudently or the contrary is still a matter of dispute. About this time Mr Pitt had devised to him by will a considerable estate in Somersetshire, the property of Sir William Pynsent of Burton-Pynsent in that county, who, from admiration of his public character, disinherited his own relations, in order to bequeath to him the bulk of his fortune. After the dissolution of the Rockingham ministry, a new administration was formed, and, in 1766, Mr Pitt was appointed lord privy seal. At the same time he was created a peer by the titles of Viscount Pitt of Burton-Pynsent in the county of Somerset, and Earl of Chatham in the county of Kent.

Whatever might be his motives in accepting a peerage, it is certain that it proved very prejudicial to his character, and that in consequence he sank as much in popularity as he rose in nominal dignity. The great commoner, as he was sometimes called, had formed a rank for himself, on the basis of his talents and exertions, which titular honours might obscure, but could not illustrate; and, with the example of Pulteney before him, he should have been careful to preserve it untarnished by empty distinctions, shared by the mean and the worthless as well as by the great, the gifted, and the good. Lord Chatham, however, did not long continue in office after being elevated to the peerage. On the 2d of November 1768, he resigned the place of lord privy seal, and never afterwards held any public employment; nor does he appear to have been at all desirous of returning to office. He was now sixty, and the gout, by which he had so long been afflicted, disabled him, by its frequent and violent attacks, for close and regular application to business. In the intervals of his disorder, however, he failed not to exert himself upon questions of great magnitude; and, in 1775, 1776, and 1777, he most strenuously opposed the measures pursued by the ministers in the contest with America. His last appearance in the House of Lords was on the 2d of April 1778. He was then very ill, and much debilitated; but the question was important, being a motion of the Duke of Richmond to address his majesty to remove the ministers, and to make peace with America on any terms. His lordship made a long speech, in which he summoned up all his remaining strength to pour out his disapprobation of a measure so inglorious. But the effort overcame him, for in attempting to rise a second time, he fell down in a convulsive fit; and though he recovered for the time, his disorder continued to increase until the 11th of May, when he expired at his seat at Hayes. His death was lamented as a national loss. As soon as the news reached the House of Commons, which was then sitting, Colonel Barré made a motion, that an address should be presented to his majesty, requesting that the Earl of Chatham should be buried at the public expense. But Mr Rigby having proposed the erection of a statue to his memory, as more likely to perpetuate the sense of his great merits entertained by the public, this was unanimously agreed to. A bill was soon afterwards passed, by which L.4000 a year was settled upon John, now Earl of Chatham, and the heirs of the late earl to whom that title might descend. His lordship was married in 1754 to Lady Hester, sister of Earl Temple, by whom he had three sons and two daughters.

The principal outlines of Pitt's character have been variously sketched, sometimes with, and sometimes without, any depth of shadow. The truth is, that there scarcely ever lived a person who had less claim to be painted altogether *en beau*, or who so little merited unsparing censure. "That he was a great man cannot for a moment be doubted; but his was not a complete and well-proportioned greatness. The public life of Hampden or of Somers resembles a regular drama, which can be criticised as a whole, and every scene of which is to be viewed in connection with the main action. The public life of Pitt, on the other hand, is a rude though striking piece, abounding in incongruities, and without any unity of plan, but redeemed by some noble passages, the effect of which is increased by the tameness or extravagance of what precedes and of what follows. His opinions were unfixed; and his conduct, at some of the most important conjunctures of his life, was evidently determined by pride and resentment. He had one fault, which of all human faults is most rarely found in company with true greatness. He was extremely affected. He was an almost solitary instance of a man of real genius, and of a brave, lofty, and commanding spirit, without simplicity of character. He was an actor in the closet, an actor in the council, an actor in parliament; and even in private society he could not lay aside his theatrical tones and attitudes. We know that one of the most distinguished of his partisans often complained that he could never obtain admittance to Lord Chatham's room till everything was ready for the representation;

till the light was thrown with Rembrandt-like effect on the head of the illustrious performer; till the flannels had been arranged with the air of Grecian drapery, and the crutch placed as gracefully as that of Belisarius or Lear."[1] Yet, with all his faults and affectations, he possessed, in a very extraordinary degree, many of the elements of true greatness. He had splendid talents, strong passions, quick sensibility, and vehement enthusiasm for the grand and the beautiful. There was something about him which ennobled even tergiversation itself. He often went wrong, very far wrong; but, amidst the abasement of error, he still retained what he had received from nature, "an intense and glowing mind." In an age of low and despicable prostitution, the age of Dodington and Sandys, it was something to have a man who might perhaps, under some strong excitement, have been tempted to ruin his country, but who never would have stooped to pilfer from her; a man whose errors arose, not from a sordid desire of gain, but from a fierce thirst of power, glory, and vengeance. "History owes him this attestation, that, at a time when anything short of direct embezzlement of the public money was considered as quite fair in public men, he showed the most scrupulous disinterestedness; that, at a time when it seemed to be generally taken for granted that government could be upheld only by the basest and most immoral arts, he appealed to the better and nobler parts of human nature; that he made a brave and splendid attempt to do, by means of public opinion, what no other statesman of his day thought it possible to do except by means of corruption; that he looked for support, not, like the Pelhams, to a strong aristocratical connection, not, like Bute, to the personal favour of the sovereign, but to the middle class of Englishmen; that he inspired that class with a firm confidence in his integrity and ability; that, backed by them, he forced an unwilling court and an unwilling oligarchy to admit him to an ample share of power; and that he used his power in such a manner as clearly proved that he had sought it, not for the sake of profit or patronage, but from a wish to establish for himself a great and durable reputation by means of eminent services rendered to the state."[2]

A great many unmeaning phrases have been employed, and much rhetorical exaggeration has been expended, in attempts to characterize Lord Chatham's style of eloquence. The following estimate by Mr Macaulay, from whom we have borrowed some of the foregoing observations, is at once deep, discriminating, and brilliant.

"In our time the audience of a member of parliament is the nation. The three or four hundred persons who may be present when a speech is delivered, may be pleased or disgusted by the voice and action of the orator; but in the reports which are read the next day by hundreds of thousands, the difference between the noblest and the meanest figure, between the richest and the shrillest tones, between the most graceful and the most uncouth gesture, altogether vanishes. A hundred years ago, scarcely any report of what passed within the walls of the House of Commons was suffered to get abroad. In those times, therefore, the impression which a speaker might make on the persons who actually heard him was everything. The impression out of doors was hardly worth a thought. In the parliaments of that time, therefore, as in the ancient commonwealths, those qualifications which enhance the immediate effect of a speech were far more important ingredients in the composition of an orator than they would appear to be in our time. All those qualifications Pitt possessed in the highest degree. On the stage, he would have been the finest Brutus or Coriolanus ever seen. Those who saw him in his decay, when his health was broken, when his mind was jangled, when he had been removed from that stormy assembly of which he thoroughly knew the temper, and over which he possessed unbounded influence, to a small, a torpid, and an unfriendly audience, say that his speaking was then, for the most part, a low monotonous muttering, audible only to those who sate close to him; that, when violently excited, he sometimes raised his voice for a few minutes, but that it soon sank again into an unintelligible murmur. Such was the Earl of Chatham; but such was not William Pitt. His figure, when he first appeared in parliament, was strikingly graceful and commanding, his features high and noble, his eye full of fire. His voice, even when it sank to a whisper, was heard to the remotest benches; when he strained it to its full extent, the sound rose like the swell of the organ of a great cathedral, shook the house with its peal, and was heard through lobbies and down stair-cases, to the court of requests and the precincts of Westminster Hall. He cultivated all these eminent advantages with the most assiduous care. His action is described by a very malignant observer as equal to that of Garrick. His play of countenance was wonderful; he frequently disconcerted a hostile orator by a single glance of indignation or scorn. Every tone, from the impassioned cry to the thrilling aside, was perfectly at his command. It is by no means improbable, that the pains which he took to improve his great personal advantages had, in some respects, a prejudicial operation, and tended to nourish in him that passion for theatrical effect which was one of the most conspicuous blemishes in his character.

"But it was not solely or principally to outward accomplishments that Pitt owed the vast influence which, during nearly thirty years, he exercised over the House of Commons. He was undoubtedly a great orator; and from the descriptions of his contemporaries, and the fragments of his speeches which still remain, it is not difficult to discover the nature and extent of his oratorical powers.

"He was no speaker of set speeches. His few prepared discourses were complete failures. The elaborate panegyric which he pronounced on General Wolfe was considered as the very worst of all his performances. 'No man,' says a critic, who had often heard him, 'ever knew so little what he was going to say.' Indeed, his facility amounted to a vice; he was not the master, but the slave of his own speech. So little self-command had he when once he felt the impulse, that he did not like to take part in a debate when his mind was full of an important secret of state. 'I must sit still,' he once said to Lord Shelburne on such an occasion, 'for when once I am up, everything that is in my mind comes out.'

"Yet he was not a great debater. That he should not have been so when he first entered the House of Commons, is not strange; scarcely any person has ever become so without long practice and many failures. It was by slow degrees, as Burke said, that Mr Fox became the most brilliant and powerful debater that parliament ever saw. Mr Fox himself attributed his own success to the resolution which he formed when very young, of speaking, well or ill, at least once every night. 'During five whole sessions,' he used to say, 'I spoke every night but one; and I regret only that I did not speak that night too.' Indeed it would be difficult to name any great debater who has not made himself a master of his art at the expense of his audience.

"But as this art is one which even the ablest men have seldom acquired without long practice, so it is one which men of respectable abilities, with assiduous and intrepid practice, seldom fail to acquire. It is singular that, in such an art, Pitt, a man of splendid talents, great fluency, and dauntless boldness, whose whole life was passed in parliamentary conflict, and who, during several years, was the leading minister of the crown in the House of Commons, should never have attained to high excellence. He spoke without premeditation; but his speech followed the course of his own thoughts, and not that of the previous discussion. He could, indeed, treasure up in his memory some detached expression of an hostile orator, and make it the text for sparkling ridicule or burning invective. Some of the most celebrated bursts of his eloquence were called forth by an unguarded word, a laugh, or a cheer. But this was the only sort of reply in which he appears to have excelled. He was perhaps the only great English orator who did not think it an advantage to have the last word, and who generally spoke by choice before his most formidable opponents. His merit was almost entirely rhetorical. He did not succeed either in exposition or refutation; but his speeches abounded with lively illustrations, striking apophthegms, well-told anecdotes, happy allusions, passionate appeals. His invective and sarcasm were tremendous. Perhaps no English orator was ever so much feared.

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[1] Edinburgh Review, vol. lix. pp. 509, 510.

[2] Edinburgh Review, *ubi supra*.

"But that which gave most effect to his declamation, was the air of sincerity, of vehement feeling, or moral elevation, which belonged to all that he said. His style was not always in the purest taste. Several contemporary judges pronounced it too florid. Walpole, in the midst of the rapturous eulogy which he pronounces on one of Pitt's greatest orations, owns that some of the metaphors were too forced. The quotations and classical stories of the orator are sometimes too trite for a clever school-boy. But these were niceties for which the audience cared little. The enthusiasm of the orator infected all who were near him; his ardour and his noble bearing put fire into the most frigid conceit, and gave dignity to the most puerile allusion."[1]

Such is the character of this great statesman and orator, as drawn by one masterly hand. It may perhaps both instruct and interest our readers, if we present another, delineated by an artist equally distinguished for the vigour, judgment, and fidelity with which he paints such grand pieces for the gallery of history. The preceding, as we have already said, is from the pen of Mr Macaulay: the following is understood to be from that of Lord Brougham.

"The first place among the great qualities which distinguished Lord Chatham, is unquestionably due to firmness of purpose, resolute determination in the pursuit of his objects. This was the characteristic of the younger Brutus, as he said, who had spared his life to fall by his hand,—*Quicquid vult, id valde vult;* and although extremely apt to be shown in excess, it must be admitted to be the foundation of all true greatness of character. Everything, however, depends upon the endowments in whose company it is found; and in Lord Chatham these were of a very high order. The quickness with which he could ascertain his object, and discover his road to it, was fully commensurate with his perseverance and his boldness in pursuing it; the firmness of grasp with which he held his advantage was fully equalled by the rapidity of the glance with which he discovered it. Add to this a mind eminently fertile in resources, a courage which nothing could daunt in the choice of his means, a resolution equally indomitable in their application, a genius, in short, original and daring, which bounded over the petty obstacles raised by ordinary men,—their squeamishness, and their precedents, and their forms, and their regularities,—and forced away its path through the entanglements of this base undergrowth to the worthy object ever in his view, the prosperity and the renown of his country. Far superior to the paltry objects of a grovelling ambition, and regardless alike of party and of personal considerations, he constantly set before his eyes the highest duty of a public man, to further the interests of his species. In pursuing his course towards that goal, he disregarded alike the frowns of power and the gales of popular applause; exposed himself undaunted to the vengeance of the court, while he battled against its corruptions, and confronted, unabashed, the rudest shocks of public indignation, while he resisted the dictates of pernicious agitators; and could conscientiously exclaim, with an illustrious statesman of antiquity, 'Ego hoc animo semper fui ut invidiam virtute partam, gloriam non invidiam putarem.'

"Nothing could be more entangled than the foreign policy of this country at the time when he took the supreme direction of her affairs; nothing could be more disastrous than the aspect of her fortunes in every quarter of the globe. With a single ally in Europe, the king of Prussia, and him beset by a combination of all the continental powers in unnatural union to effect his destruction; with an army of insignificant amount, and commanded by men only desirous of grasping at the emoluments, without doing the duties or incurring the risks of their profession; with a navy that could hardly keep the sea, and whose chiefs vied with their comrades on shore in earning the character given them by the new minister, of being utterly unfit to be trusted in any enterprise accompanied with 'the least appearance of danger;' with a generally prevailing dislike of both services, which at once repressed all desire of joining either, and damped all public spirit in the country, by extinguishing all hope of success, and even all love of glory; it was hardly possible for a nation to be placed in circumstances more inauspicious to military exertions; and yet war raged in every quarter of the world where our dominion extended, while the territories of our only ally, as well as those of our own sovereign in Germany, were invaded by France, and her forces by sea and land menaced our shores. In the distant possessions of the crown the same want of enterprise and of spirit prevailed. Armies in the West were paralysed by the inaction of a captain who would hardly take the pains to write a despatch recording the nonentity of his operations; and in the East, while frightful disasters were brought upon our settlements by barbarian powers, the only military capacity that appeared in their defence was the accidental display of genius and valour by a merchant's clerk, who thus raised himself to celebrity.[2] In this forlorn state of affairs, rendering it as impossible to think of peace, as it seemed hopeless to continue the yet inevitable war, the base and sordid views of politicians kept pace with the mean spirit of the military caste; and parties were split or united, not upon any difference or agreement of public principle, but upon mere questions of patronage, and share in the public spoil, while all seemed alike actuated by one only passion, the thirst alternately of power and of gain.

"As soon as Mr Pitt took the helm, the steadiness of the hand that held it came to be felt in every motion of the vessel. There was no more of wavering councils, of torpid inaction, of listless expectancy, of abject despondency. His firmness gave confidence, his spirit roused courage, his vigilance secured exertion, in every department under his sway. Each man, from the first lord of the admiralty down to the most humble clerk in the victualling office; each soldier, from the commander-in-chief to the most obscure contractor or commissary; now felt assured that he was acting or indolent under the eye of one who knew his duties and his means as well as his own, and who would very certainly make all defaulters, whether through misfeasance or through nonfeasance, accountable for whatever detriment the commonwealth might sustain at their hands. Over his immediate coadjutors, his influence swiftly obtained an ascendant which it ever after retained uninterrupted. Upon his first proposition for changing the conduct of the war, he stood single among his colleagues, and tendered his resignation should they persist in their dissent; they at once succumbed, and from that hour ceased to have an opinion of their own upon any branch of the public affairs. Nay, so absolutely was he determined to have the control of those measures, of which he knew the responsibility rested upon him alone, that he insisted upon the first lord of the admiralty not having the correspondence of his own department; and no less eminent a naval character than Lord Anson, with his junior lords, were obliged to sign the orders issued by Mr Pitt, while the writing was covered over from their eyes.

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[1] Edinburgh Review. *ubi spura.*

[2] Mr Clive, afterwards Lord Clive.

"The effects of this change in the whole management of the public business, and in all the plans of the government, as well as in their execution, were speedily made manifest to all the world. The German troops were sent home, and a well-regulated militia being established to defend the country, a large disposable force was distributed over the various points whence the enemy might be annoyed. France, attacked on some points and menaced on others, was compelled to retire from Germany, soon afterwards suffered the most disastrous defeats, and, instead of threatening England and her allies with invasion, had to defend herself against attack, suffering severely in several of her most important naval stations. No less than sixteen islands, and settlements, and fortresses of importance were taken from her in America, and Asia, and Africa, including all her West Indian colonies except St Domingo, and all her settlements in the East. The whole important province of Canada was likewise conquered; and the Havannah was taken from Spain. Beside this, the seas were swept clear of the fleets that had so lately been insulting all our colonies, and even all our coasts. Many general actions were fought and gained; one among them the most decisive that had ever been fought by our navy. Thirty-six sail of the line were taken or destroyed, fifty frigates, forty-five sloops of war. So brilliant a course of uninterrupted success had never, in modern times, attended the arms of any nation carrying on war with other states equal to it in civilization, and nearly a match in power. But it is a more glorious feature in this unexampled administration which history has to record, when it adds, that all public distress had disappeared; all discontent in any quarter, both of the colonies and parent state, had ceased; that no oppression was anywhere practised, no abuse suffered to prevail; that no encroachments were made upon the rights of the subject, no malversations tolerated in the possessors of power; and that England, for the first time and for the last time, presented the astonishing picture of a nation supporting without murmur a widely extended and costly war, and a people, hitherto torn with conflicting parties, so united in the service of the commonwealth that the voice of faction had ceased in the land, and any discordant whisper was heard no more. 'These,' said the son of his first and most formidable adversary, Walpole, when informing his correspondent abroad, that the session, as usual, had ended without any kind of opposition, or even of debate, 'These are the doings of Mr Pitt, and they are wondrous in our eyes.'

"To genius irregularity is incident, and the greatest genius is often marked by eccentricity, as if it disdained to move in the vulgar orbit. Hence he who is fitted by his nature, and trained by his habits, to be an accomplished 'pilot in extremity,' and whose inclinations carry him forth to seek the deep when the waves run high, may be found, if not 'to steer too near the shore,' yet to despise the sunken rocks which they that can only be trusted in calm weather would have more surely avoided. To this rule it cannot be said that Lord Chatham afforded any exception; and although a plot had certainly been formed to eject him from the ministry, leaving the chief control of affairs in the feeble hands of Lord Bute, whose only support was court favour, and whose only talent lay in an expertness at intrigue, yet there can be little doubt that this scheme was only rendered practicable by the hostility which the great minister's unbending habits, his contempt of ordinary men, and his neglect of everyday matters, had raised against him among all the creatures both of Downing Street and St James's. In fact, his colleagues, who necessarily felt humbled by his superiority, were needlessly mortified by the constant display of it; and it would have betokened a still higher reach of understanding, as well as a purer fabric of patriotism, if he whose great capacity threw those subordinates into the shade, and before whose vigour in action they were sufficiently willing to yield, had united a little suavity in his demeanour with his extraordinary powers, nor made it always necessary for them to acknowledge as well as to feel their inferiority. It is certain that the insulting arrangement of the admiralty, to which reference has been already made, while it lowered that department in the public opinion, rendered all connected with him his personal enemies; and, indeed, though there have, since his days, been prime ministers whom he would never have suffered to sit even as puny lords at his boards, yet were one like himself again to govern the country, the admiralty chief who might be far inferior to Lord Anson would never submit to the humiliation inflicted upon that gallant and skilful captain. Mr Pitt's policy seemed formed upon the assumption that either each public functionary was equal to himself in boldness, activity, and resource, or that he was to preside over and animate each department in person; and his confidence was such in his own powers, that he reversed the maxim of governing, never to force your way where you can win it; and always disdained to insinuate where he could dash in, or to persuade where he could command. It thus happened that his colleagues were but nominally coadjutors, and though they durst not thwart him, yet rendered no heart-service to aid his schemes. Indeed it has clearly appeared since his time, that they were chiefly induced to yield him implicit obedience, and leave the undivided direction of all operations in his hands, by the expectation that the failure of what they were wont to sneer at as 'Mr Pitt's visions,' would turn the tide of public opinion against him, and prepare his downfall from a height of which they felt that there was no one but himself able to dispossess him."

The same powerful writer, having thus sketched the character of the statesman, proceeds next to delineate that of the orator, as far as this can now be done from the extremely scanty and imperfect materials which have been preserved. The fame of Lord Chatham's eloquence is, in truth, almost wholly traditional.

"There is indeed hardly any eloquence, of ancient or of modern times, of which so little that can be relied on as authentic has been preserved; unless perhaps that of Pericles, Julius Cæsar, and Lord Bolingbroke. Of the actions of the two first we have sufficient records, as we have of Lord Chatham's; of their speeches we have little that can be regarded as genuine; although, by unquestionable tradition, we know that each of them was second only to the greatest orator of their respective countries; while of Bolingbroke we only know, from Dean Swift, that he was the most accomplished speaker of his time; and it is related of Mr Pitt (the younger), that when the conversation rolled upon lost works, and some said they should prefer restoring the books of Livy, some of Tacitus, and some a Latin tragedy, he at once decided for a speech of Bolingbroke. What we know of his own father's oratory is much more to be gleaned from contemporary panegyrics, and accounts of its effects, than from the scanty, and for the most part doubtful, remains which have reached us.

"All accounts, however, concur in representing those effects to have been prodigious. The spirit and vehemence which animated its greater passages, their perfect application to the subject-matter of debate, the appositeness of his invective to the individual assailed, the boldness of the feats which he ventured upon, the grandeur of the ideas which he unfolded, the heart-stirring nature of his appeals, are all confessed by the united testimony of all his contemporaries; and the fragments which remain bear out to a considerable extent such representations; nor are we likely to be misled by those fragments, for the more striking portions were certainly the ones least likely to be either forgotten or fabricated. To these mighty attractions was added the imposing, the animating, the commanding power of a countenance singularly expressive; an eye so piercing that hardly any one could stand its glare; and a manner altogether singularly striking, original, and characteristic, notwithstanding a peculiarly defective and even awkward action. Latterly, indeed, his infirmities precluded all action; and he is described as standing in the House of Lords, leaning upon his crutch, and speaking for ten minutes together in an under-tone of voice scarcely audible, but raising his notes to their full pitch when he broke out into one of his grand bursts of invective or exclamation. But in his earlier time, his whole manner is represented as having been beyond conception animated and imposing. Indeed the things which he effected by it principally, or at least which nothing but a most striking and commanding tone could have made it possible to attempt, almost exceed belief. Some of these sallies are indeed examples of that approach made to the ludicrous by the sublime, which has been charged upon him as a prevailing fault, and represented under the name of *charlatanerie*,—a favourite phrase with his adversaries, as it in later times has been with the ignorant undervaluers of Lord Erskine. It is related, that once in the House of Commons he began a speech with the words, 'Sugar, Mr Speaker,'—and then, observing a smile to prevail in the audience, he paused, looking fiercely around, and with a loud voice, rising in its notes, and swelling into vehement anger, he is said to have pronounced again the word 'Sugar!' three times,—and having thus quelled the house, and extinguished every appearance of levity or laughter, turned round and disdainfully asked, 'Who will laugh at sugar now?' We have this anecdote on good traditional authority; that it was believed by those who had the best means of knowing Lord Chatham, is certain; and this of itself shows their sense of the extraordinary powers of his manner, and the reach of his audacity in trusting to those powers.

"There can be no doubt that of reasoning,—of sustained and close argument,—his speeches had but little. His statements were desultory, though striking, perhaps not very distinct, certainly not at all detailed, and as certainly every way inferior to those of his celebrated son. If he did not reason cogently, he assuredly did not compress his matter vigorously. He was anything rather than a concise or a short speaker; not that his great passages were at all diffuse, or in the least degree loaded with superfluous words; but he was prolix in the whole texture of his discourse, and he was certainly the first who introduced into our senate the practice, adopted in the American war by Mr Burke, and continued by others, of long speeches,—speeches of two and three hours, by which oratory has gained little, and business less. His discourse was, however, fully informed with matter—his allusions to analogous subjects, and his reference to the history of past events, were frequent—his expression of his own opinions was copious and free, and stood very generally in the place of any elaborate reasoning in their support. A noble statement of enlarged views, a generous avowal of dignified sentiments, a manly and somewhat severe contempt for all petty or mean views, whether their baseness proceeded from narrow understanding or from corrupt bias, always pervaded his whole discourse; and, more than any other orator since Demosthenes, he was distinguished by the nobleness of feeling with which he regarded, and the amplitude of survey which he cast upon, the subject-matters of debate. His invective was unsparing, and hard to be endured, although he was a less eminent master of sarcasm than his son, and rather overwhelmed his antagonist with the burst of words and vehement indignation, than wounded him by the edge of ridicule, or tortured him with the gall of bitter scorn, or fixed his arrow in the wound by the barb of epigram. These things seemed, as it were, to betoken too much labour and too much art, more labour than was consistent with absolute scorn, more art than could stand with heartfelt rage, or entire contempt inspired by the occasion, at the moment, and on the spot. But his great passages, those by which he has come down to us, those which gave his eloquence its peculiar character, and to which its dazzling success was owing, were as sudden and unexpected as they were natural. Every one was taken by surprise when they rolled forth; every one felt them to be so natural, that he could hardly understand why he had not thought of them himself although into no one's imagination had they ever entered. If the quality of being natural without being obvious is a pretty correct description of felicitous expression, or what is called fine writing, it is a yet more accurate representation of fine passages, or felicitous *hits* in speaking. In these all popular assemblies take boundless delight; by these, above all others, are the minds of an audience at pleasure moved or controlled. They form the grand charm of Lord Chatham's oratory; they were the distinguishing excellence of his great predecessor, and gave him at will to wield the fierce democraty of Athens, and to fulmine over Greece."[1]

Many years ago, a small volume was published by Lord Grenville, containing letters written by the Earl of Chatham to his nephew, Thomas Pitt, Lord Camelford. They are replete with excellent advice, conveyed in an easy, affectionate, and not inelegant style, having all of them been penned evidently without effort, under the simple impulse of the kindly feelings and anxious interest which they manifest throughout. At the same time they might have been written by a person vastly inferior to Lord Chatham; and indeed one can scarcely avoid surprise at the absence of every trace of that genius, power, and originality, for which the writer was so greatly distinguished. We may add, that amidst the different conjectures which have at various times been entertained and abandoned, respecting the authorship of Junius, Lord Chatham has once and again been pointed to as the writer of these celebrated and still unclaimed letters; nor can it be doubted by one who has made himself master of the question, that there are circumstances of a very striking kind which appear to give a certain colour of probability to this supposition. Indeed it would not be difficult, we think, to make out as strong a case in his favour as any that has yet been offered to the public in behalf of others, none of whom had his "motive and cue for action." But as time, the great revealer of all mysteries, will most likely, ere long, remove the veil by which this is covered, we shall not add to the mass of doubtful speculation by reviving a discussion which, by a sort of tacit consent, has for some time been abandoned as unprofitable and nugatory. (A.)

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[1] Edinburgh Review, vol. lxviii. p. 438, et seq.

Pitt, *William*, the second son of the preceding, and his legitimate successor in talents and celebrity as a statesman and orator, was born on the 28th of May 1759. His father, having confided the care of his eldest and youngest sons to others, took William under his own inspection; and the rapid progress of the son cheered the solitude and brightened the declining days of this illustrious statesman. The school exercises of the youth were performed under the direction of a private tutor well qualified for the task assigned him; whilst his father, finding in him a capacity above his years, embraced every opportunity of conversing freely with him upon topics of interest, calculated to expand his mind and mature his judgment. It is even said that he also made him declaim from a chair or table; well knowing the importance of an easy, natural, and dignified elocution, which, in his own case, had helped to supply the deficiencies of fortune. The proficiency of the youth was such that, at the age of fourteen, he was found qualified for being sent to the university; and Cambridge was preferred to Oxford, from a decided opinion entertained by many, that the political doctrines inculcated at the former place were more liberal than those usually promulgated at the latter. He was accordingly entered at Pembroke Hall, where he was placed under the tuition of Dr Turner; whilst Dr Prettyman, afterwards Tomline, and successively bishop of Lincoln and of Winchester, officiated as his private instructor. During his residence at Cambridge, Mr Pitt was distinguished alike for the assiduity of his application, and the success that attended his efforts to acquire those branches of knowledge to which his studies were more particularly directed; nor have many young men of rank ever passed through the ordeal of an university, exposed to the contaminating influence of seductive example, with a higher character for morals, abilities, industry, and regularity. Here young Pitt took his bachelor's degree, and also that of master of arts, both in a creditable manner; and acquired a reputation for talents, diligence, and propriety of deportment, which proved eminently serviceable to him in after life. Being intended by his father for the bar and the senate, his education was regulated so as to embrace both these objects; and it is certain that his early acquisitions in various branches of knowledge must have far exceeded those of almost any of his contemporaries.

After quitting the university, he went to the Continent, and passed a short time at Rheims, the capital of Champagne. The death of his father, however, whilst he was only in his nineteenth year, could scarcely fail to throw a cloud over the prospects of the younger son; but the foundation of future distinction had been firmly laid, and it only remained for him to clear the path to eminence by his own exertions. He had already entered himself a student of Lincoln's Inn; and as soon as he came of age he was called to the bar, having received some favour on account of his degree. He made choice of the western circuit, and appeared in several causes as junior counsel; in which capacity, of course, he had few or no opportunities of distinguishing himself. The result of this short experiment, however, was thought sufficient to encourage him to pursue the career of the law, and rendered it almost certain that he would ultimately attain a high rank in his profession; but a seat in parliament, which he soon afterwards obtained, gave his ambition its proper direction, and placed him in the arena where he was best calculated to excel. At the general election in 1780, he had been induced to offer himself as a candidate for the representation of the university of Cambridge; but finding that, from want of sufficient influence, he had no chance of success, he declined the contest, and in the following year was returned for the borough of Appleby, through the interest of Sir James Lowther, afterwards Earl of Lonsdale.

This, be it observed, was during the period of most violent political opposition to the American war; which, it may be supposed, Mr Pitt regarded with hereditary aversion, and reprobated as one of the most disgraceful and ruinous contests in which the country could have engaged. He was also ardently attached to the cause of political reform, particularly in the representation of the people; which he conceived to be the best safeguard of constitutional liberty, and the only security against the recurrence of such wars as that which he so much deplored and condemned. On the 26th of February 1781, Mr Pitt made his first speech in the British senate. At the commencement of the session Mr Burke had brought forward his bill for effecting great retrenchments in the civil list; and it was in reference to this measure that Mr Pitt made his débût in the House of Commons. The attention of the house was naturally fixed upon the son of the great Chatham; but in a few moments the regards of the audience were directed to him on his own account. Unembarrassed by the novelty of his position, and master alike of his feelings and his subject, he delivered himself with an ease and grace, a richness of expression, a closeness of argument, and a classical precision of language, which not only answered, but exceeded all the expectations that had been formed of him, and elicited great applause from both sides of the house. During the same and the subsequent session, he spoke several times, particularly in favour of parliamentary reform, of which, as we have just stated, he was a zealous advocate; and, from his talents as a public speaker, it soon became evident that he was destined to perform a prominent part upon the political stage.

But although, for the most part, he ostensibly went along with the party in opposition to Lord North, yet he had not formed any decided connection with them; and hence, when his lordship was driven from power, and a new administration formed, with the Marquis of Rockingham at its head, Mr Pitt's name was not included in the list. This cabinet, however, was of short endurance. Lord Rockingham died suddenly; and his death having occasioned a fatal difference as to the choice of a new head, the Earl of Shelburne, profiting by the circumstance, formed a junction with several members of the former cabinet, and having (in July 1782) been appointed first lord of the treasury, associated with himself Mr Pitt, who had just completed his twenty-third year, as chancellor of the exchequer. A general peace with America, and the powers in alliance with the Transatlantic republic, followed soon afterwards; but this having been made a ground of severe censure by a powerful opposition, a coalition was formed between Lord North and Mr Fox, and, in April 1783, the Shelburne administration was forced to give way to this extraordinary confederacy, which had in some measure dictated its own terms to the sovereign. During his continuance in office, Mr Pitt had found but little opportunity of distinguishing himself, except as an able defender of the measures of administration, and a vigorous assailant of the principles and conduct of his antagonists. But a circumstance soon occurred which constitutes an important era in his life, and not only proved the eventual cause of his return to office, but secured to him a degree of authority with the king, and of popularity with the nation, which has seldom fallen to the lot of any minister, and which he preserved with but little diminution till the close of his life.

The coalition ministry was, both in its formation and in its character, odious to the country at large. It was regarded as an unprincipled combination for purposes purely selfish; in its formation all the old landmarks and distinctions of party had been thrown down; and as its composition was such as to afford no hopes of future benefit to the nation, its proceedings were watched with the jealous vigilance of suspicion and hatred. Whilst matters were in this state, Mr Fox introduced his bill for regulating the affairs of India. The leading provision of this famous project was to vest the whole management of Indian affairs in seven commissioners named in the bill, and to be appointed by the ministry; or, in other words, to transfer the whole patronage of India from the Crown and the Company, to the administration for the time being. In vain was it represented that this measure would prove alike advantageous to the Company and the nation; that it would introduce responsibility where there was none, or next to none; and that it would serve to prevent abuses, which were described as equally flagrant and notorious. The public generally considered it as trenching too much upon the prerogative, as creating a mass of ministerial influence which would be irresistible, and as rendering the ministry too strong for the crown. In opposing it, therefore, Mr Pitt had rather to follow than to lead public opinion, to obey the impulse already given, than to endeavour to excite and stimulate opposition; and this he did with so much skill and ability, that although the bill passed the House of Commons, it was thrown out in the Lords. This defeat decided the fate of the coalition ministry. For although it were true, as the partisans of the ministers alleged, that the rejection of the bill had been caused by secret intrigue and undue influence, this made no difference in regard to public opinion, which was decidedly adverse to the measure; and hence the country was not disposed to find fault with the means by which the end desired had been obtained. The ministry therefore resigned, and in the new arrangement Mr Pitt was made first lord of the treasury and chancellor of the exchequer.

Having thus become prime minister at the early age of twenty-four, Mr Pitt's appearance in that high and difficult station was greatly applauded by his friends, and at the same time ridiculed by his opponents, who represented it as the arrogant assumption of a stripling, indebted to accident or intrigue for a position from which he would be driven in a few months, perhaps even sooner. And at first it seemed by no means improbable that this prognostication would be fulfilled. In the House of Commons, the adherents of the coalition ministry were still so numerous, that, when Mr Pitt introduced his bill for the regulation of Indian affairs, it was rejected by a majority of eight (222 to 214); and in this state matters remained for some months. In the mean time several meetings were held by the leading men of both parties, and various projects of accommodation discussed; but Mr Pitt's previous resignation being demanded as a *conditio sine qua non*, all these attempts failed. Resolved to stand by the sovereign who confided in, and the people who supported him, Mr Pitt now took a step, the very boldness of which, perhaps, conduced to his success, we mean, dissolving parliament. This took place in March 1784, and was speedily followed by a general election, in which thirty coalitionists, including some of the leading men of the party, lost their seats; so that the minister was enabled to meet the new parliament with a decided majority, and an opposition more weakened in talent than in numbers. His India bill, which the last parliament had thrown out, was now re-introduced and passed; an addition was made to the window-tax, in order to supply the deficiency occasioned by a reduction of the principal duties upon tea; and various plans were proposed for the more effectual prevention of smuggling.

At this period, indeed, the grand object of Mr Pitt's ambition seems to have been, to acquire the reputation of an able and successful minister of finance. In 1786, he brought in and carried through a bill for establishing his famous sinking fund, upon a plan which, it seems, had been suggested to him by Dr Richard Price, and which, as modified in the bill, was long regarded by his friends and partisans as the *ne plus ultra* of financial skill and ingenuity. But all this ignorant admiration was at length dissipated by the masterly work of Dr Hamilton; and even Lord Grenville, the friend and colleague of Mr Pitt, found himself constrained to admit, in a pamphlet which he published on the subject, after his retirement from public life, that the whole scheme was bottomed upon delusion. In the year 1787, Mr Pitt concluded a commercial treaty with France; and amongst the subsequent measures in which he was personally concerned, may be mentioned his accession to the impeachment of Warren Hastings, his opposing the repeal of the corporation and test acts, his interference in behalf of the stadtholder, the affair of Oczakow, and the dispute with Spain respecting the fur-trade at Nootka Sound, several of which were extremely unpopular.

But the most important epoch of Mr Pitt's political life was now approaching. His reforming and patriotic zeal had already been sensibly cooled. Instead of seeking to strengthen himself in the affections of the people, he began to think only of establishing himself firmly in the favour of the court; and, whilst pursuing this object, a circumstance occurred which raised him to the summit of power, and enabled him, as prime minister, to exercise every function of his office without check or control. This was the illness of the king, which took place in the autumn of 1788, and incapacitated his majesty for the exercise of the royal functions. Parliament had been prorogued to the 20th of November; and as the sovereign, by whom alone it could be further prorogued, was not in a condition to exercise his prerogative, it became necessary that it should meet upon that day. A question of great nicety and delicacy now arose; namely, in whom the office of regent was to be vested. The Prince of Wales being then connected with the party in opposition, Mr Fox strenuously contended that the regency devolved upon him as a matter of course, without restriction or limitation; whilst Mr Pitt, on the other hand, maintained that it belonged to the two remaining branches of the legislature to fill up the office as they should judge proper, and impose such restrictions as they might deem necessary; at the same time admitting that, under actual circumstances, no other person than the prince could be thought of for the regency, thus limited by the two houses of parliament. The view of the prime minister prevailed, and a bill was in consequence passed, greatly restricting the power of the regent. But its provisions were soon rendered inoperative, by the convalescence of his majesty in the beginning of 1789. It is certain, however, that, upon recovering the use of his reason, the king greatly approved of the course which Mr Pitt had pursued; and the latter was in consequence established in power more firmly than ever. We may add, that on the recurrence of a similar visitation, with still more melancholy circumstances, the precedent of 1788–1789 served as a guide to the minister of the day, Mr Percival, and the Prince of Wales became regent, subject to restrictions analogous to those which had formerly been imposed by Mr Pitt.

The next great epoch in Mr Pitt's political life, and which, beyond all the preceding portions of his conduct, will determine his character as a statesman with posterity, was the French Revolution; taken in connection with the policy which the government of this country, under the sole guidance of Mr Pitt, pursued in reference to that mighty convulsion, and the astounding events to which it gave birth. But as Mr Pitt, considered individually, cannot be separated from the history of the long and sanguinary war with France, in which, principally through his means, the country became involved; and as the most ample details, both of the policy of this country, and the strange vicissitudes of the contest, have already been given under the article BRITAIN, it is only necessary to refer the reader to that head for the fullest information on these points, as well as respecting the most important domestic events of Mr Pitt's long administration, the rebellion in Ireland, and the subsequent union of that country with Great Britain. Suffice it to say, that having held the reins of government for eighteen years, Mr Pitt, and all the members of his cabinet, retired from office in 1801. The French armies had been victorious all over the continent; Prussia had, at an early period, prudently withdrawn from the contest; Austria had been completely humbled; and a successful soldier, under the denomination of First Consul, had assumed the reins of government in France. All Mr Pitt's plans for humbling that country, and, as it were, rolling back the Revolution, had most signally failed; the cry for peace was now become general; and a breathing-time, at least, had become indispensably necessary. But it was left to Mr Addington to make the experiment, and, under his auspices, the treaty of Amiens was concluded with the French government.

But, as every reflecting person had foreseen, this armistice (for it was nothing more) proved of short duration. The war broke out again in the year 1803; and Mr Pitt, having gradually withdrawn his support from the Addington administration, it fell to pieces from its own inherent fragility. In 1804, Mr Pitt, having resumed the reins of government, exerted all his ability to give a successful turn to the contest, and organized a new coalition against France. But the thunder-stroke of Austerlitz blasted all his hopes, again placed Austria at the feet of the conqueror, and left Prussia exposed to that vengeance which soon afterwards descended upon her as a just retribution for her treachery. The prime minister was at this time in a state of health ill calculated to bear up under such a blow. A gouty habit, the predisposing causes of which appear to have been hereditary, and a too liberal use of wine as part of his ordinary regimen, undermined a constitution which had never been very robust; and these, added to the cares and anxieties of office, at a period of so great excitement, brought on a premature exhaustion of the vital powers. In December 1805 he went to Bath; but the change afforded him no permanent relief. On the 11th of January 1806, he returned to his seat at Putney, much debilitated, and there lingered on till the 23d of the same month, when he expired, in the forty-seventh year of his age. A public funeral was decreed to him by parliament, and forty thousand pounds were voted to discharge those debts which he was said to have incurred in the service of the state.

Though Mr Pitt possessed no particular advantages of person or of physiognomy, yet as a speaker he was considered by many as of surpassing eminence. Happy in the choice of his words, judicious in the arrangement of his subject, and gifted with a natural flow of eloquence, his wonderful powers were acknowledged even by those who dissented from his doctrines, and remained unmoved by his arguments. When employed in a good cause, he was irresistible; in defending a bad one, he could dazzle the judgment, mislead the imagination, and seduce the heart, even when he could not overcome the understanding. In statement or exposition he was clear, perspicuous, and singularly adroit, not to say artful; in sarcasm and invective he was tremendous. But although ambition and the love of power were his ruling passions, his mind was elevated above the meanness of avarice; his personal integrity remained unimpeached; and though he died involved in debts, these are to be ascribed to negligence, and the demands of his public station, rather than to extravagance, or any fondness for splendour and parade. Though his manner, in his public deportment, was distant and reserved, not to say haughty, yet few men were ever more successful in fixing the attachment of their private and personal friends. By all those who shared his intimacy he seems to have been esteemed and beloved. "They saw the all-powerful energies of his character," says Mr Rose, "softened into the most perfect complacency and sweetness of disposition in the circles of private life, the pleasures of which no one more cheerfully enjoyed, or more agreeably promoted, when the paramount duties which he conceived himself to owe to the public admitted of his mixing in them. That indignant severity with which he met and subdued what he considered unfounded opposition, that keenness of sarcasm with which he expelled and withered, as it might be said, the powers of most of his assailants in debate, were exchanged, in the society of his intimate friends, for a kindness of heart, a gentleness of demeanour, and a playfulness of good humour, which no one ever witnessed without interest, or participated without delight." Mr Wilberforce, who knew him intimately, entertained the same opinion of his social qualities, when he moved in the circle of his particular friends. "Though less formed for general popularity than Fox," says he, "Pitt, when free from shyness, and amongst his intimate companions, was the very soul of merriment and conversation. He was the wittiest man I ever knew, and, what was quite peculiar to himself, he had at all times his wit under entire control. Others appeared struck by the unwonted association of brilliant images; but every possible combination of ideas seemed always present to his mind, and he could at once produce whatever he desired. I was one of those who met to spend an evening in memory of Shakspeare, at the Boar's Head, East Cheape. Many professed wits were present, but Pitt was the most amusing of the party, and the readiest and most apt in the required allusions."[1]

This, it will be observed, applies to an early period of his career, when his faculties were in all the freshness and vigour of youth. But from other accounts we learn, that amidst all the anxieties and disappointments of his public life, he retained to the last the reputation of being a most amiable companion in the circle of his private friends. The Marquis of Wellesley's character of him, which we subjoin, is perhaps a little overdrawn, and has something of a controversial character about it, having been written in refutation of certain statements of Sir Nathaniel Wraxall, who, amongst other things, had said that "Pitt's manners were stiff, retired, and without unction or grace;" but, making every allowance for the partialities of friendship, considerable weight must be given to the deliberate estimate of one who, himself a great statesman, an elegant scholar, and an accomplished man, enjoyed the best opportunities of appreciating the character and attainments of his friend.

"In attempting to convey to you my recollection of Mr Pitt's character in private society," says his lordship, "I cannot separate those qualities which raised him to the highest public eminence from those which rendered him a most amiable companion. Both proceeded from the same origin, and both were happily blended in the noble structure of his temper and disposition.

"Mr Pitt's mind was naturally inaccessible to any approach of dark, or low, or ignoble passion. His commanding genius and magnanimous spirit were destined to move in a region far above the reach of those jealousies, and suspicions, and animosities, which disturb the course of ordinary life. Under the eye of his illustrious father he had received that 'complete and generous education which fits a man to perform justly, skilfully, and magnanimously, all the offices, both private and public, of peace and war.' Such an education, acting on such a natural disposition, not only qualified him to adorn the most elevated stations in the counsels of his country, but furnished him with abundant resources to sustain the tranquillity and cheerfulness of his mind.

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[1] Life of Wilberforce, vol. ii. p. 18.

"He had received regular and systematic instruction in the principles of the Christian religion, and in the doctrine and discipline of the Church of England, and in every branch of general ecclesiastical history. His knowledge in those subjects was accurate and extensive. He was completely armed against all sceptical assaults, as well as against all fanatical illusion; and, in truth, he was not merely a faithful and dutiful, but a learned member of our established church; to which he was most sincerely attached, with the most charitable indulgence for all dissenting sects. No doubt can exist in any rational mind that this early and firm settlement of his religious opinions and principles was a main cause of that cheerful equanimity which formed the great characteristic of his social intercourse, and which was never affected by adversities nor troubles.

"He was perfectly accomplished in classical literature, both Latin and Greek. The accuracy and strength of his memory surpassed every example which I have observed; but the intrinsic vigour of his understanding carried him far beyond the mere recollection of the great models of antiquity in oratory, poetry, history, and philosophy; he had drawn their essence into his own thoughts and language; and, with astonishing facility, he applied the whole spirit of ancient learning to his daily use.

"Those studies were his constant delight and resort; at Holwood, in Kent (his favourite residence), and at Walmer Castle, his apartments were strewed with Latin and Greek classics; and his conversation with those friends who delighted in similar studies frequently turned on that most attractive branch of literature; but he was so adverse to pedantry or affectation of superior knowledge, that he carefully abstained from such topics in the presence of those who could not take pleasure in them. In these pursuits his constant and congenial companion was Lord Grenville, who has often declared to me that Mr Pitt was the *best Greek scholar* he ever conversed with. Mr Pitt was also as complete a master of all English literature as he was undoubtedly of the English language. I have dwelt on this branch of Mr Pitt's accomplishments because I know not any source from which more salutary assistance can be derived, to chase from the spirits those clouds and vapours which infest vacant minds, and, by self-weariness, render retirement melancholy and intolerable.

"But Mr Pitt amply possessed every resource which could enliven retirement. No person had a more exquisite sense of the beauties of the country. He took the greatest delight in his residence at Holwood, which he enlarged and improved (it may be truly said) with his own hands. Often have I seen him working in his woods and gardens with his labourers for whole days together, undergoing considerable bodily fatigue, and with so much eagerness and assiduity, that you would suppose the cultivation of his villa to be the principal occupation of his life.

"He was very fond of exercise on horseback, and when in the country frequently joined the hounds of his neighbourhood, both at Holwood and Walmer Castle.

"At the latter place he lived most hospitably, entertaining all his neighbours, as well as the officers of the neighbouring garrisons, and of the ships in the Downs; and he was most attentive to his duties of lord warden of the cinque ports, which called him frequently to Dover, and sometimes to the other ports.

"But in all places, and at all times. his constant delight was society. There he shone with a degree of calm and steady lustre which often astonished me more than his most splendid efforts in parliament. His manners were perfectly plain, without any affectation; not only was he without presumption or arrogance, or any air of authority, but he seemed utterly unconscious of his own superiority, and much more disposed to listen than to talk. He never betrayed any symptom of anxiety to usurp the lead or to display his own powers, but rather inclined to draw forth others, and to take merely an equal share in the general conversation: then he plunged heedlessly into the mirth of the hour, with no more care than to promote the general good humour and happiness of the company. His wit was quick and ready, but it was rather lively than sharp, and never envenomed with the least taint of malignity; so that, instead of exciting admiration or terror, it was an additional ingredient in the common enjoyment. He was endowed, beyond any man of his time whom I knew, with a gay heart and a social spirit. With these qualities he was the life and soul of his own society. His appearance dispelled all care; his brow was never clouded, even in the severest public trials; and joy, and hope, and confidence beamed from his countenance in every crisis of difficulty and danger.

"He was a most affectionate, indulgent, and benevolent friend, and so easy of access, that all his acquaintance, in any embarrassment, would rather resort to him for advice than to any person who might be supposed to have more leisure. His heart was always at leisure to receive the communications of his friends, and always open to give the best advice in the most gentle and pleasant manner.

"It is a melancholy but a grateful task to pay this tribute to the memory of my departed friend. 'Aut me amor negotii suscepti fallit,' or the character which I have endeavoured to draw is not less just and true than it is amiable and excellent; and I cannot resist the conclusion, that a pure and clear conscience must have been the original source of such uniform cheerfulness and gaiety of spirit. The truth which I have asserted I possessed ample means of knowing. From the year 1783 to 1797 I lived in habits of the most confidential friendship with Mr Pitt.

"In the year 1797 I was appointed governor-general of India, and in the month of September in that year I went to Walmer Castle to meet Mr Pitt and Mr Dundas, and to receive my last instructions. I found Mr Pitt in the highest spirits, entertaining officers and country gentlemen with his usual hospitality. Amongst others, Admiral Duncan was his constant and favourite guest. His fleet was then in the Downs, preparing for the memorable victory of Camperdown. The admiral was a lively and jovial companion, and seemed to be quite delighted with Mr Pitt's society. I embarked for India early in the month of November 1797, and I returned to England in January 1806.

"Not wishing to state any thing beyond my own personal knowledge, I will not attempt to relate the history of Mr Pitt's social habits during the period of my absence; but I cannot believe that, during that time, the whole frame of his magnificent mind had been so broken and disjointed, that he could not endure the temporary loss of power, nor reconcile himself to that retirement, and to those recreations, which were his relief from the labour of official business, and his consolation in the hour of political solicitude and care. But I know that the first summer after his resignation was passed with Mr Addington at Wimbledon, and that soon afterwards Mr Pitt was closely occupied at Walmer Castle in forming a corps of volunteer cavalry, living with his officers, and passing the greater part of his time on horseback, under the firm expectation of a French invasion. This does not well agree with the story which represents him wrapped in sullen seclusion, sunk in despondency, shunning all society, and

Pitt.

yet unable to relieve the gloom of solitude by any mental resource.

"On my arrival in England in January 1806, Mr Pitt was at Bath; I wrote to him, and I received from him a very kind invitation to meet him at Putney Hill. I met him accordingly, in the second week in January, and I was received by him with his usual kindness and good humour. His spirits appeared to be as high as I had ever seen them, and his understanding quite as vigorous and clear.

"Amongst other topics, he told me, with great kindness and feeling, that, since he had seen me, he had been happy to become acquainted with my brother Arthur, of whom he spoke in the warmest terms of commendation. He said, 'I never met any military officer with whom it was so satisfactory to converse. He states every difficulty before he undertakes any service, but none after he has undertaken it.'

"But notwithstanding Mr Pitt's kindness and cheerfulness, I saw that the hand of death was fixed upon him. This melancholy truth was not known nor believed by either his friends or opponents. In the number of the latter, to my deep affliction, I found my highly respected and esteemed friend Lord Grenville, and I collected that measures of the utmost hostility to Mr Pitt were to be proposed in both houses at the meeting of parliament. I warned Lord Grenville of Mr Pitt's approaching death. He received the fatal intelligence with the utmost feeling, in an agony of tears, and immediately determined that all hostility in parliament should be suspended. Mr Pitt's death soon followed."

In a character of Lord Chatham,[1] lately published, and which is generally ascribed to Lord Brougham, that great orator and powerful writer thus contrasts the elder and younger Pitt as public men and ministers:

"The true test of a great man,—that at least which must determine his place among the highest order of great men,—is his having been in advance of his age. This it is which decides whether or not he has carried forward the grand plan of human improvement, has conformed his views, and adapted his conduct, to the existing circumstances of society, or changed those so as to better its condition; has been one of the lights of the world, or only reflected the borrowed rays of former luminaries, and sat in the same shade at the same twilight or the same dawn with the rest of his generation. Tried by this test, the younger Pitt cannot certainly be said to have lived before his time, or shed upon the age to which he belonged the illumination of a more advanced civilization and more inspired philosophy. He came far too early into public life, and was too suddenly plunged into the pool of office, to give him time for the study and the reflection which can alone open to any mind, how vigorous soever be its natural constitution, the views of a deep and original wisdom. Accordingly, it would be difficult to glean, from all his measures and all his speeches, any thing like the fruits of inventive genius; or to mark any token of his mind having gone before the very ordinary routine of the day, as if familiar with any ideas that did not pass through the most vulgar understandings. His father's intellect was of a higher order."[2]

Lord Brougham's opinion of the oratory of the younger Pitt is recorded in the conclusion of the following passage:

"Some have compared Mr Fox's eloquence to that of Demosthenes; but it resembled Lord Chatham's just as much, if not more. It was incomparably more argumentative than either the Greek or the English orator's, neither of whom carried on chains of close reasoning as he did, though both kept close to their subject. It was, however, exceedingly the reverse of the Attic oration, either in method, in diction, or in conciseness. It had nothing like arrangement of any kind. Except in the more vehement passages, its diction was perhaps as slovenly, certainly as careless, as possible,—betokening indeed a contempt of all accurate composition. It was diffuse in the highest degree, and abounded in repetitions. While the Greek was concise, almost to being jejune, the Englishman was diffuse, almost to being prolix. How the notion of comparing the two together ever could have prevailed, seems unaccountable, unless it be that men have supposed them alike because they were both vehement, and both kept the subject in view rather than run after ornament. But that the most elaborate and artificial compositions in the world should have been likened to the most careless, and natural, and unprepared that ever were delivered in public, would seem wholly incredible if it were not true. The bursts of Mr Fox, however, though less tersely and concisely composed, certainly have some resemblance to Lord Chatham's,—only that they betray far less fancy,—and, however vehement and fiery, are incomparably less bold. Mr Pitt's oratory, though admirably suited to its purpose, and as perfect a business kind of speaking as ever was heard, certainly resembled none of the three others who have been named. In point of genius, unless perhaps for sarcasm, he was greatly their inferior; although, from the unbroken fluency of his appropriate language, and the power of a most sonorous voice, he produced the most prodigious effect." (A.)

Pitt's Island || Pittacus.

PITT'S ISLAND, a small mountainous island in the South Pacific Ocean, covered with wood. Long. 193. 14. E. Lat. 11. 50. S.

PITT'S *Straits*, in the Eastern Seas, separate the islands of Salwatty and Battanta, at the western extremity of Papua or New Guinea, and extend from west-south-west to east-south-east about thirty miles, being about six in average breadth. No bottom is found in the middle with seventy-five fathoms of line.

PITTACUS, a native of Mitylene, in Lesbos, was one of the seven wise men of Greece. His father's name was Hyrradius. With the assistance of the sons of Alcæus, he delivered his country from the oppression of the tyrant Melanchrus; and, in the war which the Athenians waged against Lesbos, he appeared at the head of his countrymen, and challenged to single combat Phrynon, the enemy's general. As the event of the war seemed to depend upon this combat, Pittacus had recourse to artifice, and, when engaged, entangled his adversary in a net which he had concealed under his shield, and easily despatched him. He was amply rewarded for this victory; and his countrymen, sensible of his merit, unanimously appointed him governor of their city, with unlimited authority. In this capacity, Pittacus behaved with the greatest moderation and prudence; and after he had governed his fellow-citizens with the strictest justice, and enforced the most salutary laws, he voluntarily resigned the sovereign power after having enjoyed it for ten years; observing, that the virtues and innocence of private life were incompatible with the power and influence of a sovereign. His disinterestedness gained him many admirers; and when the Mitylenians wished to reward his public services by presenting him with an immense tract of territory, he refused to accept more land than could be contained within the space to which a javelin could be thrown. He died in the seventieth year of his age, about 579 years before Christ, after he had spent the last ten years of his life in literary ease and peaceful retirement.

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[1] See Edinburgh Review, vol. lxviii. p. 436, et seq.

[2] "Mr Pitt had foibles," says Mr Wilberforce, "and of course they were not diminished by a long continuance in office; but for a clear and comprehensive view of the most complicated subject in all its relations; for that fairness of mind which disposes a man to follow out, and, when overtaken, to recognise truth; for magnanimity, which made him ready to change his measures when he thought the good of the country required it, though he knew he should be charged with inconsistency; for willingness to give a fair hearing to all that could be urged against his own opinions, and to listen to the suggestions of other men, whose understandings he knew to be inferior to his own; for personal purity, disinterestedness, integrity, and a love of his country, I have never known his equal. His strictness in regard to truth was astonishing, considering the situation he had so long filled." (Life of Wilberforce, vol. iii. p. 249, 250.)

PITTENWEEM, a royal burgh and seaport town on the Frith of Forth, in the parish of the same name, and on the east coast of Fifeshire. It is situated on gently-elevated ground, which overhangs the harbour, and consists of an irregular main street, having the form of an oblong square, from which a number of by-streets stretch out along the public roads. The houses are chiefly of old date, with the exception of a neat range of respectable cottages on the north side of the town. In the main street are situated the town-house, the parish church (an old ungainly structure, with a turreted spire), and all that remains of the ancient priory of Pittenweem. In addition to the ruins of the priory, there is a quadrangular range of most antique houses, which are stated to have been the residences of the prior and other superior officers of the establishment. This ancient edifice is now included within the private property of a gentleman, who resides in a part of it. The town derives its name from a spacious cave, called a *weem*, hollowed out, partly by the action of the waves, and partly by art, from the rock on which stands the residence alluded to. There is also a communication between the prior's house and the cave, by means of a spiral stair, the orifice of which has, however, been lately built up. Besides the established church, there is an Episcopalian chapel, and one or two dissenting places of worship. Pittenweem was erected into a royal burgh in the year 1542, and, like all the other Fifeshire burghs, had a thriving and extensive trade, which was carried on with success till the time of the union, from which date its importance and its trade have alike declined. It was also a great fishing station, and much coal was once wrought here; but both are now considerably decreased. The harbour is very much exposed to easterly winds but it has been improved so far as the means of the town will allow, and is now rather an extensive work. The revenue of the burgh amounts to above L.550, and its expenditure to nearly the same amount. In the year 1833, the town was in debt to the amount of L.1621 sterling. The burgh is governed by a council, consisting of four bailies, a treasurer, and nineteen councillors; and, with St Andrews, the two Anstruthers, Crail, Cupar, and Kilrenny, it returns a member to parliament. The population in 1821 amounted to 1200, and in 1831 to 1317.

PIUS, a name of several pontiffs distinguished in the history of the Catholic church.

Pius II. (*Æneas Sylvius Piccolomini*) was born on the 18th of October 1405, at Corsigni, in the Siennese, the name of which he afterwards changed into that of *Pienza*. Æneas was carefully educated, and made considerable proficiency in the belles lettres. After having finished his studies at Sienna, he in 1431 went to the council of Basil with Cardinal Capranica, surnamed *De Fermo*, because he was intrusted with the government of that church. Æneas, who acted as his secretary, was then only twenty-six years of age. He afterwards acted in the same capacity to some other prelates, and to Cardinal Albergati. The council of Basil honoured him with different commissions, in order to recompense him for the zeal with which he had defended that assembly against Pope Eugenius IV. He was afterwards secretary to Frederic III., who decreed to him the poetical crown, and sent him as ambassador to Rome, Milan, Naples, Bohemia, and other places. Nicholas V. advanced him to the bishopric of Trieste, which he quitted some time afterwards for that of Sienna. At last, after having distinguished himself as nuncio on various occasions, he was invested with the Roman purple by Calixtus III., whom he succeeded two years afterwards, on the 27th of August 1458. Pius II., now advanced to the holy see, exemplified the proverb, "Honores mutant mores." From the commencement of his pontificate he appeared to be jealous of the papal prerogatives. In 1460 he issued a bull, declaring appeals from the pope to a council to be null, erroneous, detestable, and contrary to the sacred canons. That bull, however, did not prevent the procurator-general of the parliament of Paris from appealing to a council in defence of the Pragmatic Sanction, which the pope had strenuously opposed. Pius was then at Mantua, whither he had gone to engage the Catholic princes to unite in a war against the Turks. The greater part of them had agreed to furnish troops or money; but others refused both, particularly France, which from that moment incurred his holiness's aversion. But his aversion abated under Louis XI., whom in 1461 he persuaded to abolish the Pragmatic Sanction, which the parliament of Paris had with so much vigour supported.

The following year, 1462, was rendered famous by a controversy which took place between the Cordeliers and Dominicans, whether or not the blood of Jesus Christ was separated from his body whilst he lay in the sepulchre. It was also made a question whether it was separated from his divinity. The Cordeliers affirmed that it was, but the Dominicans were of an opposite opinion. As usually happens in such disputes, the disputants called each other heretics; and this obliged the pontiff to issue a bull, forbidding them, under pain of censure, to brand one another with such odious epithets. The bull which his holiness published on the 26th of April, retracting what he had written to the council of Basil when he was its secretary, if it somewhat impeached his consistency, was at least highly honourable to his frankness and candour. "I am a man," says he, "and as a man I have erred. I am far from denying that a great many things which I have said and written may deserve condemnation. Like Paul, I have preached through deception, and I have persecuted the church of God through ignorance. I imitate the blessed St Augustin, who having suffered some erroneous sentiments to creep into his works, retracted them. I do the same thing; I frankly acknowledge my ignorance, from a fear lest what I have written in my younger years should be the occasion of any error that might afterwards be prejudicial to the interests of the holy see. For if it be proper for any one to defend and support the eminence and glory of the first throne of the church, it is in a peculiar manner my duty, whom God, out of his mercy and goodness alone, without any merit on my part, has raised to the dignity of vicar of Jesus Christ. For all these reasons, we exhort and admonish you in the Lord, not to give credit to those writings of ours which tend in any degree to hurt the authority of the apostolic see, and which establish opinions that are not received by the Roman church. If you find, then, any thing contrary to her doctrine, either in our dialogues, in our letters, or in other of our works, despise these opinions, reject them, and adopt our present sentiments. Believe me rather now that I am an old man, than when I addressed you in my earlier days. Esteem a sovereign pontiff more than a private person; except against Æneas Sylvius, but receive Pius II." It might perhaps be objected to his holiness, that it was his dignity alone which had made him alter his opinion. He anticipates that objection by giving a short account of his life and actions, with the whole history of the council of Basil, to which he went with Cardinal Capranica in 1431; "but," says he, "I was then a young man, and without any experience, like a bird just come from its nest." In the mean time, the Turks were threatening Christendom. Pius, ever zealous in the defence of religion against the infidels, formed the resolution of fitting out a fleet at the expense of the church, and of passing over into Asia himself, to animate the Christian princes by his example. He repaired to Ancona with a design to embark; but he there fell sick from the fatigue of the journey, and expired on the 16th of August 1464, aged fifty-nine. Pius was one of the most learned men of his time, and also one of the most zealous pontiffs; but being of an ambitious disposition, he sometimes sacrificed to that weakness. His principal works are, 1. Memoirs of the Council of Basil, from the Suspension of Eugenius to the Election of Felix; 2. The History of the Bohemians, from their origin to the year 1458; 3. Two books on Cosmography; 4. The History of Frederic III. (whose vice-chancellor he had been), published in 1785, in folio; 5. A Treatise on the Education of Children; 6. A Poem upon the Passion of Jesus Christ; 7. A Collection of four hundred and thirty-two Letters, printed at Milan, 1473, in folio, in which are found some curious anecdotes; 8. The Memoirs of his Own Life, published by John Gobelin Personne, his secretary, and printed at Rome in 1584, in 4to; 9. *Historia Rerum Ubicumque Gestarum*, of which only the first part was published at Venice in 1477, in folio. His works were printed at Helmstadt in 1700, in folio, with a life prefixed.

PIVOT, or PIVAT, a foot or shoe of iron or other metal, usually conical or terminating in a point, whereby a body, intended to turn round, bears upon another fixed at rest, and performs its revolutions. The pivot usually bears or turns round in a sole, or piece of iron or brass hollowed to receive it.

PIZARRO, FRANCIS, a celebrated Spanish general, the discoverer and conqueror of Peru, in conjunction with Diego Almagro, a famous Spanish navigator. They are both charged with having committed horrid cruelties on the inhabitants; and they fell victims to their own ambition, jealousy, and avarice. Almagro having revolted, was defeated and beheaded by Pizarro, who again was assassinated by Almagro's friends in 1541. See the article PERU.

PIZZO, a city of Italy, in the province of Calabria Ulteriore II., and kingdom of Naples. It is situated on a promontory on the south side of the Gulf of Euphemia. It was destroyed by the tremendous earthquake of 1783, but has been again rebuilt, and contains upwards of 5000 inhabitants, the most industrious of the population of Calabria. They have been freed from taxes on salt, and from some other imposts, since 1815, when they resisted the attempt of Murat, who landed near it. This has promoted the fishery, and especially the curing of fish. The country around it is highly productive of corn, oil, figs, and mulberry trees, and yields much silk.

PLACE, in *Astronomy*. The place of the sun, a planet, or a star, denotes the sign and degree of the zodiac which the luminary is in; or the degree of the ecliptic, reckoning from the beginning of Aries, which the planet's or star's circle of longitude cuts; and therefore coincides with the longitude of the sun, planet, or star. As the sine of the sun's greatest declination, 23° 30′, is to the sine of any present declination given or observed, for instance, 23° 15′; so is the radius 10 to the sine of its longitude, 81° 52′; which, if the declination were north, would give 20° 52′ of Gemini, or, if south, 20° 52′ of Capricorn, for the sun's place.

PLACENTIA, a city of Spain, in the province of Estremadura, the capital of a partido of the same name, which comprises two fruitful districts on the two sides of the river Vera. It is situated on the river Xerte, between two hills, and has been fortified, but its defences have been neglected. It has seven gates protected by towers, twenty-two streets and squares, seven churches, as many monasteries, five hospitals, two colleges, 950 houses, and 5200 inhabitants, who are occupied in tanning leather, and in making hats and pottery ware. The district around produces much honey and bees' wax, which adds to its trade. The city is supplied with water by means of a fine aqueduct of eighty arches.

PLAGIARY, the purloiner of another man's works. Amongst the Romans, *plagiarius* was properly a person who bought, sold, or retained a freeman for a slave; and was so called because, by the Flavian law, such persons were condemned *ad plagas*, or to be whipped. Thomasius has an express treatise *de plagio literario*, wherein he lays down the laws and measures of the right which authors have to use one another's writings.

PLAGUE. The terms pest, pestilence, and plague, were long employed in Great Britain, as were the corresponding terms in other languages, both in ancient and in modern times, to denote simply a disease attacking a great number of persons simultaneously and in succession, and destroying a large proportion of those whom it attacked; in short, a widely-diffused and malignant epidemic. At the present day these terms are restricted to signify a particular form of disease, of frequent occurrence in the countries bordering on the eastern extremity of the Mediterranean, the Levant and Archipelago, but occasionally appearing also in countries more or less remote from these regions.

Symptoms by which the plague is characterized.

The disease in question, the plague of the Levant, as it is often termed, exhibits, not in every individual case, but in a large proportion of those affected in the progress of its epidemic prevalence, two classes of symptoms, the constitutional and the local. Under the constitutional symptoms may be comprehended those indicatory of fever of a malignant or typhoid character, with various concomitant phenomena that are in wont to attend fever of this character in different regions of the globe; the local consist chiefly of glandular swellings, or buboes as they are termed, and of malignant or gangrenous boils, or carbuncles.

Relations of the constitutional and local symptoms.

These two classes of symptoms stand variously related to one another in different individual cases; and even, there seems reason to believe, in different periods of the same epidemic. Dr Patrick Russell, in his Treatise of the Plague, in which he has given the results of his own extensive observation of this disease during its epidemic prevalence in Aleppo in the years 1760, 1761, and 1762, mentions one class of patients who seldom or never had buboes or carbuncles; and another class, in a few of whom, when the disease proved quickly fatal, these symptoms were likewise absent. "These two eruptions," he says, "are equally diagnostics of the true plague; their presence, separately or in conjunction, leaves the nature of the distemper unequivocal; but fatal has been the error of rashly, from their absence, pronouncing a distemper not to be the plague, which in the sequel has depopulated regions, and which early precaution might probably have prevented from spreading." Dr Louis Frank, also, mentions, that though the appearance of buboes is the most constant and characteristic symptom of the plague, yet he has seen many affected with this disease, in whom buboes were altogether wanting, or appeared only at the period of death. As cases of this kind are particularly liable to occur at the commencement of an epidemic, a considerable number of persons may, it is obvious, come to be affected, before the pestilential character of the disease is ascertained, or even suspected, particularly in regions in which the plague is of rare occurrence.

But as the constitutional symptoms of plague may occur without the local, so the local may occur with little fever or constitutional disturbance of any kind. Dr Russell, under his fifth class of cases, to which he refers those of slight infection, in which all the infected recovered, and which, he says, "was very numerous," mentions, that in these the access was often attended with so little apparent disorder, that the eruptions gave the first alarm, "the buboes were often the first symptom of infection;" and the fever, which came on afterwards, was frequently so slight as not to confine the sick to the house: others found themselves indisposed for two or three days, but were not sensible of any febrile heat whatever. In these cases, and in some others in which the fever ran somewhat higher, but without the concurrence of alarming symptoms, "all the infected had buboes or carbuncles, and very often both eruptions concurred in the same subject. Persons not confined by indisposition were often, by the inguinal buboes, prevented from walking abroad."

In cases of plague in which both the constitutional and the local symptoms manifest themselves, there is considerable difference in the relative time of their appearance. "In a very large proportion of the sick," Dr Russell informs us, "the buboes made their appearance in the course of the first day; but in many instances they did not appear before the second or third day, or even later."

In the few remarks we purpose to offer relative to the plague, we shall consider some points of its natural history, as it presents itself, 1*st*, in the countries in which it is of frequent occurrence; and, 2*d*, in those countries in which it rarely shows itself.

Its occurrence on the borders of the Levant, &c.

I. In the countries bordering on the Levant and Archipelago, the plague is liable to present itself either in single, or, as they are termed by medical men, *sporadic* cases; or in a great number of cases simultaneously or in succession, so as to constitute an *epidemic*.

Its sporadic occurrence.

It is stated, indeed, by Dr Patrick Russell, that "in the intervals between the plagues of Aleppo," that is to say, between the successive epidemic prevalences of this disease, "the city remains absolutely free; and the plague is never sporadic there, except in its beginning and decline; it never subsists for any length of time in a few scattered cases without consequence." But this statement is not conformable with the reports of others. M. Pugnet, who accompanied Bonaparte's expedition to Egypt, affirms, in his *Mémoire sur les Fièvres du mauvais caractère du Lévant*, that that country is seldom absolutely free from the plague during several successive years; and that in almost every month of every year there occur a number of cases, though these are not noted when they do not occasion its epidemic prevalence. Sir James M'Grigor, who had the medical charge of the army which was brought from India to Egypt in 1801, in like manner expresses his belief that "the contagion of plague is seldom or never out of Egypt." Dr Murdoch Mackenzie, in his Letters concerning the Plague at Constantinople, published in the Philosophical Transactions, vol. xlvii. remarks, that during the twenty years he had lived at Constantinople and Smyrna, there had scarcely been a year, excepting three, in which the plague did not threaten more or less, with little or no perceptible difference in the character of the season to explain it. The late Sir Thomas Maitland, who had occasion, whilst governor-general of Malta and the Ionian Islands, to apply his vigorous mind to the investigation of the natural history of the plague, came to the conclusion, that, though subject to variations in respect of prevalence in the countries in question, this disease is never wholly extinct in any of them. "We find," says Sir Thomas, "that, whether it be in Egypt, at Smyrna, or Constantinople, an effort has been made to convince the world that the plague stops in these places at certain seasons, and commences at others. For my own part, I can only say, that he would be a bold man who would venture to assert that the plague ever is eradicated at any season of the year, in any one of the three places just mentioned; on the contrary, I hold nothing more certain, than that it constantly exists in them all, showing itself with greater violence at one time than at another, and hardly taken notice of till it arrives at such a height as to be seriously alarming to the whole community."[1]

Frequency of its epidemic prevalence.

Various estimates have been given of the frequency of plague epidemics in the principal towns of Egypt, Syria, and Turkey. Prosper Alpinus, who resided in Egypt between 1580 and 1584, refers to a belief of its recurring in that country every seventh year, but represents this belief as being incorrect. Dr Alexander Russell mentions it as the common opinion of the inhabitants of Aleppo, that they are visited with the plague about once in ten years; which opinion, he observes, seems in some measure to be founded on experience. Dr Mackenzie, writing from Constantinople in 1763, says, that "the plague is now more frequent in the Levant than it was when I first came into this country, about thirty years ago; for then they were almost strangers to it in Aleppo and Tripoli of Syria, and they had it but seldom at Smyrna; whereas now they have it frequently at Aleppo, and summer and winter in Smyrna, which," he adds, "must be owing to the great communication by commerce all over the Levant, and more extended into the country villages than it used to be."

Disappearance during a particular part of the year.

When the plague assumes an epidemic character in the countries in which it is common, the epidemic frequently continues for several years; not, however, uninterruptedly, for in general it is observed, that for a part of the year the disease in a great measure or altogether disappears, breaking out again after an interval of various duration. In the same way, in non-epidemic seasons, sporadic cases of plague are seldom or never met with during a particular portion of the year. It seems reasonable to conclude that this disappearance of plague, or great abatement in its prevalence, during a particular portion of the year, must be connected with some peculiar condition of the weather then prevailing, and consequently that the period must be liable to variations, not only in different countries, but also to some extent in the same country in different years.

Season at which this occurs.

Dr L. Frank mentions his having been assured that at Cairo the time of year in which the operation of the plague-poison is suspended uniformly commences with the summer solstice (21st June), as stated by Prosper Alpinus with regard both to that city and to Egypt generally; but that at Alexandria, Rosetta, and Damietta, that is, in the towns along the coast, the plague terminates about the feast of St John (24th June), though not uniformly every year, as it sometimes continues till about the middle of July. In respect to the period of the plague's terminating at Cairo, Dr P. Russell mentions, that several accounts which, on making strict inquiry, he received from persons long resident in that city, Europeans as well as natives, all concurred in the fact of the plague's declining rapidly in June, but not ceasing entirely; and he particularly refers to information which he had received of the Europeans having remained, in 1759, shut up till the middle of July, "which was considered as very extraordinary." Dr Russell also remarks, that in most places in the Levant, a popular tradition is to be found of the extinction of the plague at a certain fixed period, which varies, however, at different places. At Aleppo, he adds, it is fixed nearly a month later than at Cairo. His brother, Dr A. Russell, states, that at Aleppo the plague comes to its height in June, decreases greatly in July, and certainly disappears in August. Mr Dawes, chaplain to the factory at Aleppo, says, that in all the plagues with which Aleppo had been visited in the eighteenth century up to that of 1761, the contagion is said to have regularly and constantly ceased in August and September. But that which prevailed in the year last mentioned proved the fallacy of general observations on this subject; for, from the end of March 1761, to the middle of September 1762 (that is, for a continued period of seventeen and a half months), scarcely a day passed without some deaths or fresh attacks from the distemper; and though its violence ceased in autumn, yet on an average he believes it was fatal to at least thirty persons in every week, from that time to the end of the winter. Dr P. Russell, in reference to the same epidemic, says,—"The natives all agreed in declaring the plague had never before been so formidable in the winter; and many went so far as to affirm that it was the first instance of the plague's having been ever known at all at that season. But what happened in the year 1742 was entirely forgotten; and the cases in the present winter, however strongly marked, will probably, in the course of a few years more, be obliterated from the memory of the people of Aleppo, leaving them as tenacious as before of a traditionary opinion, that the city stands secure from the plague in the winter." At Smyrna, according to Mr Hayes, the virulence of the disorder is almost invariably over by August. From the statement of Dr Mackenzie, it appears that the plague began at Constantinople in 1751 about the middle of May, and continued uninterruptedly more than sixteen months, that is, up to the latter end of September 1752. In 1753, it began the last day of May, and continued uninterruptedly till the middle of September 1754.

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[1] Dispatch to Earl Bathurst, of date the 8th April 1819; ordered to be printed the 17th June 1825.

Season of its re-appearance.

Admitting that, in general, though certainly not universally, plague disappears in Egypt soon after the 21st of June, in Syria about a month later, and probably at a still more advanced period of the year in Asia Minor and Turkey, is there any constancy in regard of its re-appearance? Sir J. M'Grigor mentions that the month of November, or more usually of December, is the time of year in which the plague is wont to re-appear in Egypt, and that, according to the observation of the natives, when it breaks out before December, they have always a generally prevailing and very destructive disease. According to Pugnet, there are three periods in the prevalence of the plague in Egypt: its *invasion*, which occupies the months of December, January, and February; its *acme*, which occupies March, April, and May; and its *extinction*, which occurs suddenly during the second half of June. Frank says, that, according to the general accounts, the plague seldom occurs in Egypt in the months of September, October, November, December, and January, but usually appears in the months of February, March, and April; and he adds, conformably with Sir J. M'Grigor's statement, that "it is well ascertained, that when it begins in September or October, it is more terrible than if it appears later, because it then continues for a longer time, and is the cause of greater mortality. Perhaps, also, the pestilential miasma becomes more deadly." At Aleppo, according to Dr A. Russell, the plague is constantly moderated during the winter, and grows more violent as the spring advances. Mr Hayes mentions the months of March and April as the period at which the plague usually begins at Smyrna. Timone states in regard to the plague at Constantinople, that it is pretty soundly lulled by the cold of winter, emitting, however, here and there sparks during that season as well as in spring; it increases in summer, and rages with the greatest violence in August. The spread of the infection is not stopped by the coldish north winds blowing at stated times of the summer; but if the south winds blow during that season, constantly and of sufficient warmth, they suppress the plague.

We shall presently have occasion to see the application of these facts relative to the periods at which the plague subsides and revives in Egypt, Syria, and Turkey, to the explanations that have been proposed of the causes or agencies by which this disease is produced.

Nature of the agent by which it is produced.

Great difference of opinion has subsisted as to the nature of the agent which, by its operation on the animal economy, produces this form of disease; whether the plague is generated by a particular state of the atmosphere, itself the result of the reciprocal action of various concurrent agents, and which is sufficient to produce the disease in a large proportion of those who are exposed to its influence, as is the case in respect of ague or intermittent fever; or whether the disease is communicated from person to person through the medium of some impalpable effluvium from the body, as in the cases of measles and scarlet fever? Whether, in the language of medical men, the plague depends on terrestrial or atmospheric miasm, improperly named infection by some, or upon human contagion.

The quarantine laws.

The laws of quarantine, so far as they refer to the plague, obviously proceed on the supposition that this disease is capable of being communicated by person to person; and also that the plague-poison is capable of being imbibed by substances that have come in contact with the bodies of those affected, or that have been exposed to the air which they breathe; of remaining attached to such substances for a considerable space of time, when excluded from free ventilation; of mixing with the atmosphere when exposed to it, and infecting those who breathe it; or of communicating the disease to persons who touch or handle the articles to which it is attached. The inconvenience with which the enforcement of the quarantine laws is necessarily attended, particularly to those engaged in commerce, has naturally rendered many anxious for their repeal or modification. The grounds upon which those who have represented them as unnecessary have rested their case, may be referred to the two following: 1*st*, That the plague always depends on miasm, and consequently, where the circumstances necessary for the production of plague-miasm concur, the disease will happen in spite of all quarantine regulations; and, 2*d*, that supposing the disease to be contagious, there are climates in which its contagion cannot be received and propagated, and consequently, as regards these, quarantine laws must be superfluous.

Dependence on contagion satisfactorily established.

The evidence in favour of the contagious character of the plague in Egypt, Syria, Turkey, &c. and of its dissemination both by person and by fomites, as deduced from the places and individuals that escape, as well as from the places and individuals that become affected, is so ample and complete, as to leave room for doubt only in minds pre-occupied with theoretical dogmata, or considerations of personal advantage. Accordingly, the opinion adverse to the contagious character of plague in these countries, seems to be now very generally abandoned by those who can be regarded as impartial and competent judges of the fact. When a select committee was appointed by the House of Commons in 1819, to consider the validity of the doctrine of contagion in the plague, all the medical men examined, with the exception of two, were in favour of the received doctrine, that the plague is a disease communicable by contagion. One of these anti-contagionists in plague was Dr Charles Maclean, the other Dr Mitchell. Of the medical officers of the French and English armies in Egypt between 1799 and 1802, who have published an account of the diseases which presented themselves to their observation during that campaign, Assalini seems to have been the only one who came to the conclusion that the plague is not a truly contagious disease, and that it is produced solely by local causes.

Whether also dependent on terrestrial miasma.

By some, however, it has been supposed that both terrestrial miasm and human contagion are concerned in spreading the plague, the disease being first generated by miasm, but subsequently diffusing itself, by contagion, both in the districts in which the miasm is produced, and in countries to which it does not extend, and in which it cannot be supposed to be generated. Amongst those holding this doctrine, there has been a difference of opinion as to the number of districts in which the supposed plague-miasm may be produced. Some conceive that there is one particular portion of the globe only in which the circumstances essential for the development of plague-miasm occur in combination; an opinion readily adopted by the different nations and provinces among whom the disease frequently prevails, though they differ very much as to the parent soil, each being desirous to transfer that odium from itself to its neighbour. M. Fodéré, who, though he had never personally seen the plague, had bestowed much pains in studying its history, maintains that the plague is a production of the soil of Lower Egypt alone; that is to say, of the combination of the waters of the Nile, and of the materials brought down by that river, with the vegetable earth of the Delta, when, after the inundation, the heat causes these waters to be volatilized, and gives rise to the creation of an immense multitude of insects and of reptiles. When the disease has once been produced in the human body by this miasm, he has no doubt as to its being capable of being communicated from person to person. He holds, therefore, that in Lower Egypt, the plague is both an endemic and a contagious disease; whilst, when it occurs in Upper Egypt, in Syria, and the other countries of Turkey, and in Europe, it is simply a contagious disease, being transported to them from Lower Egypt.

Dependence on atmospheric conditions;

Others, again, are of opinion, that in Egypt, as elsewhere, the plague always requires a human effluvium for its production and communication; but that the propagation of this contagious effluvium is greatly influenced by, if not dependent upon, particular conditions of the atmosphere. This unknown condition of the atmosphere is supposed either to cause the effluvia of non-pestilential diseases to assume a pestilential character, or the plague-effluvium to be generated of a peculiarly virulent character, or to render the human body more susceptible of its action. The influence of the atmosphere in promoting and in checking plague seems sufficiently established by the circumstances already stated relative to the variations in its prevalence in the different seasons of the year; but in what manner or by what qualities the atmosphere exerts this influence, is a matter of the greatest uncertainty.

on temperature;

Some authors have been of opinion, that it is simply the *temperature* of the atmosphere which determines the prevalence of plague in the countries along the shores of the Mediterranean; that the atmosphere may be either too hot or too cold for its propagation. Thus Dr A. Russell mentions, that the season wherein the plague always ceases at Aleppo, is that in which the heats are the most excessive. "Extreme heat," he says, "seems to check the progress of the disease; for though, during the few first hot days, the mortality, as well as the number of those newly infected, increase, yet a few days' longer continuance of that weather greatly diminishes the number of the sick." Mr Dawes, in mentioning August and September as the months in which the plague usually, though not constantly, ceases at Aleppo, notices them as being the hottest months in the year. Conformably with the same view, the occurrence of the hot winds is conceived by some to be the agent which puts a stop to the prevalence of the plague in Egypt. From the statements of Timone, and of several other authors, as we have already seen, it appears that, at Constantinople, the cold of winter generally exercises a great influence in suppressing or diminishing the extension of this disease. Dr James Frank, who was upon the expedition with Sir Ralph Abercromby in the year 1800, and had the first establishment of the Plague Hospital at Aboukir, says, in his evidence before the committee of the House of Commons in 1819, "the great cold of Constantinople puts an end to it, and the great heat of Cairo puts an end to it." And to the same effect Mr Edward Hayes, a native of Smyrna, and who had resided there nearly forty-four years, on being asked by the committee, "When does the plague generally subside in your country?" replied, "When the great cold or the great heat destroys it."

on heat and moisture conjointly.

M. Pugnet, again, affirms that the prevalence of the plague in Egypt is always proportional to the *moisture* of the atmosphere taken in connection with its *heat*, whether the moisture shall depend on a greater than usual inundation of the Nile, or on the fall of rain; and explains by these different sources of moisture the plague making its appearance in different districts of Egypt in different years. The circumstance of the heat bearing either a very great or a very small proportion to the moisture of the atmosphere, is, according to Pugnet, unfavourable to the extension of plague; but at the same time he holds, that besides moisture and heat, the germ of the disease, as he terms the contagious principle, is requisite for its development. In noticing that most of those who have travelled in Egypt say the plague is brought there from Greece, and those who have travelled in Greece pretend that that country only receives it from Egypt, M. Pugnet remarks,—"I think that the defenders of Egypt and those of Greece are equally in the right; the plague comes no less from Egypt than from Greece, or from Greece than from Egypt. It has established itself a durable focus in these two opposite points; and when one of them seems to become extinguished, the other revives it."

Supposed connection with the overflowing of the Nile.

Dr L. Frank, who, after sojourning with the French army in Egypt, subsequently resided for a year in Tunis, and travelled for six years over the continent of Greece, principally for the purpose of investigating everything connected with the plague, is adverse to the idea of the production of the pestilential poison being in any way connected with the overflowing of the Nile. The Nile begins to decrease in September, and in December all the waters disappear from the inundated surface. Consequently, he argues, if the putrefaction of stagnant waters could produce the plague, this disease should manifest itself chiefly in the months of October, November, and December, whilst, in fact, it very rarely occurs in these months. And as the increase of the Nile in the month of June is very small, it cannot be supposed to be the occasion of the extinction of the plague which occurs at that season. Besides, the plague occurs in some years when the increase of the river has been small, and does not occur in other years when the increase has been considerable. Frank has no doubt that the plague may be generated in Egypt; but in many instances he thinks it is imported into it from other countries, just as it is liable to be carried from it to other countries. He suggests, that when the plague manifests itself rapidly without any other epidemic having preceded it, it has probably been imported; but that when an epidemic, petechial, malignant, or nervous fever has previously occurred, it is very probable that these diseases have degenerated, and produced the contagious principle of the plague. Frank conceives, with Alpinus, that it is in the character of the *winds* that the cause of the prevalence or cessation of the plague in Egypt is to be looked for; the unhealthy season corresponding with the part of the year during which the winds and weather are variable, and the healthy season with the period during which the north wind blows steadily, that is, from June to September.

Dependence on the prevailing winds.

Supposition of plague-poison being reproduced from time to time.

Those who, in admitting the contagious character of the plague, have argued in favour of the possibility of its poison being engendered independently of human effluvia, and simply from the reciprocal action of the atmosphere and the earth upon one another, seem to have been led to this view by their believing that the plague-poison is wholly extinguished during a certain portion of the year, and consequently, that for the reproduction of the disease there must be a reproduction, or *generatio de novo*, as medical men term it, of the poison.

When by the return of the period of the year which is unfavourable to its dissemination, the plague ceases, one of two things may happen. It may remain absent from the country or district for a succession of years, or it may recur with the period of the year which is compatible with its propagation. Now it does not appear to be necessary, in either of these cases, to admit the supposition of a fresh generation of pestilential poison from terrestrial miasmata. In the case of the shorter interval, the epidemic may have slumbered, but not died; in short, there may have occurred sporadic cases of the disease, in sufficient number to maintain the stock. When, again, a more considerable interval elapses between the cessation of the plague and its re-appearance at a particular place, a fresh importation may have taken place from regions in which it has been prevailing epidemically during its absence from the country under observation.

Besides being maintained by sporadic cases during the non-epidemic season of the year, the contagion of the plague may also be maintained in the form of *fomites*, that is, attached to substances that have been in contact with the bodies of patients, or exposed to the air which they breathe. Dr Russell mentions, that at Aleppo, in 1762, several instances occurred of the revival of plague in houses which had suffered the year before, attended with circumstances highly suspicious of the contagion having been preserved several months for want of cleansing. It has very generally been believed, also, that by fomites the contagion of plague may be carried to regions very remote from that in which these substances acquired it. When the articles to which the pestiferous poison has attached itself are freely exposed to ventilation, it does not seem to be retained for any considerable length of time; but when, on the contrary, they are excluded from open communication with the air, there is good ground for suspecting that the poison may remain attached to them for a long space of time. Indeed we are not acquainted with any natural limit to its continuance, besides that of the free exposure of the fomites to the air.

Circumstances diminishing the probability of infection.

In considering the plague to be capable, at least during a certain portion of the year, of being diffused by contagion, it is not necessarily inferred that all persons who approach within a given distance of a person labouring under the disease must become affected with it. There seem to be a variety of circumstances that diminish the probability of infection, with some of which we are more or less acquainted, whilst of others we are entirely ignorant.

1*st*, It has been supposed that exposure during one period of the epidemic is attended with less risk of infection than exposure during another. 2*d*, That exposure to a mild case of plague is attended with less risk of infection than exposure to one of a very malignant character. 3*d*, That a person who is exposed to plague-contagion by degrees, runs less risk of infection than one who is suddenly brought within the sphere of its operation. 4*th*, That persons possessing equanimity of mind, of temperate habits, &c. run less risk than those who are in opposite circumstances.

Individual peculiarities in respect of the susceptibility or non-susceptibility of plague-contagion are very singular and unaccountable; but not more so than are observed in respect of other contagious diseases. A person whose exposure to the affected has been slight and of short continuance, may be seized with the disease; whilst another who has undergone a very great degree of exposure remains free. And a person who has remained free during close and long-continued exposure, may ultimately become affected, without any change of circumstances, extrinsic or intrinsic, which it is possible to detect.

Dr L. Frank conceives that the proportion of persons who pass their life in Egypt without experiencing an attack of plague, is greater than the proportion of persons who never experience an attack of small-pox, which he reckons as scarcely one in ten thousand.

Possibility of recurrence in the same individual.

It has been much disputed whether having once passed through plague renders a person unsusceptible of re-infection; and if it does not afford absolute security against more than one attack, in what proportion of cases a second or more frequent recurrence takes place. Some authors have denied the reality, if not the possibility, of a second attack of plague; others have related, as very singular events, single cases which had been noticed in particular epidemics; whilst others again represent such occurrences as by no means rare. Dr Mackenzie mentions his having been assured by the Greek Padré, who took care of the Greek hospital at Smyrna for fifty years, that he had had the plague twelve different times during that period; and it is very certain, adds Dr Mackenzie, that he died of it in 1736. The abbé who took care of the Frank Hospital at Pera, assured Dr M. that he had had the disease at Constantinople and at Smyrna four different times.

Latent period of infection.

In various respects it is extremely desirable to know what length of time may elapse between a person's exposure to plague-poison, and the appearance of the disease. On the decision of this question, it is obvious, the duration of personal quarantine should be founded. Dr P. Russell mentions, that at Aleppo, he met with no instance of the disease appearing later than the ninth or tenth day after the day of shutting up, in those who adopted that precaution. Sir J. M'Grigor, in noticing that in different people, and under different circumstances, there is the greatest variety in respect of the time the matter of the pestilential contagion takes before it comes into action, mentions one case in which ten days seemed to be the shortest period that could possibly have intervened; and another in which a person continued well till the seventeenth day after being placed in quarantine.

In other countries than those of the Levant.

II. The few remarks which we have room to offer relative to the plague, as occurring occasionally in other regions than those bordering on the Levant and Archipelago, must bear reference chiefly to the question, whether, admitting the plague to be a contagious disease in the countries we have hitherto alluded to, there is any reason to apprehend the possibility of its being introduced into the British isles; or whether the quarantine laws, as regards the plague, might be safely abolished. To justify such a measure, it would, it appears to us, be necessary to establish the correctness of one or other of the following propositions:—1*st*, That it is impossible, in the nature of things, that the plague should exist in the British isles; and that, in point of fact, it never existed in them: 2*d*, That if it ever existed in these islands, it was indigenous, not imported, and consequently could not have been prevented by quarantine laws: or, 3*d*, That if it ever was imported into these islands, it was under circumstances which cannot recur.

Possibility of plague occurring in the British isles.

1*st*, Our opinion, as to whether a particular disease can occur in any country, may rest upon two grounds; the first, our belief as to the conditions on which its prevalence in the countries it is known to infest may depend; and the second, our knowledge as to whether it has ever prevailed in the country in former times. These two considerations may reflect mutual light on each other. If we are very certain as to the conditions requisite for the existence of the particular disease, and are told that it has occurred in a country which we know not to fulfil these, we will disbelieve the correctness of the statement. And, conversely, if we are perfectly satisfied that the disease has prevailed in a country which does not fulfil the conditions we are disposed to consider requisite for its existence, our opinion as to these conditions must be modified. In respect of the plague, it is plain, from the discrepancies which we have seen to prevail in the explanations given of the causes by which it is produced and propagated in Egypt, &c. that the reality of its existence is exposed to much less dubiety than the explanation of the conditions on which that existence depends.

The fact already mentioned, of the very wide signification that used to be attached to the term plague or pest, renders it necessary, indeed, that in judging whether a particular epidemic was really plague or not, we should not trust to the mere name which it received, but inquire into the symptoms which it actually exhibited. But, with symptoms so very characteristic as those that attend true plague, or rather, as we have already said, a large proportion of the cases that occur in the course of a plague-epidemic, a very slight description of a *pestilence* must suffice for determining as to its identity with genuine plague. Accordingly, we have experienced considerable surprise, in looking over the evidence taken by the committee of the House of Commons in 1819, at the number of witnesses who either positively denied that the so-called plague in London of 1665 (to omit previous epidemics to which that title was applied) was really that disease, or expressed much doubt on the subject. If the general statement of Sydenham to that effect left any room for doubt on this head, the minute description of Dr Hodges, and particularly the portion of it that relates to the more peculiar symptoms, including buboes, carbuncles, &c. is more than sufficient, we should have thought, to remove all doubt from the minds of the most sceptical.

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2*d*, As to the plague of 1665 having been indigenous, and not imported, we have a very explicit statement of Dr Hodges as to its having been brought from Turkey to Holland, and from Holland to England. Attempts have indeed been made to point out discrepancies in his explanation of its first appearance and propagation in England; but to us the objections appear inconclusive, and the deficiencies in the chain of proofs such as might occur in tracing the diffusion of a disease universally recognised as contagious. The non-recurrence of the plague in this country since that period is certainly not more easy to explain, on the supposition of the epidemic in question having been indigenous, than on that of its having been imported.

3*d*, The circumstances favourable to the reception and dissemination of plague-contagion, which may be supposed to have existed in 1665, but to be now extinct and incapable of recurring, may be of different kinds. The beneficial change may be in the character of the climate, in the condition of the soil, or in the habits of the people. But if our immunity has depended on a change in the climate, who can be responsible for the continuance of this change? What the climate has been, it may, for any thing we know, become again. And as to any immunity that could be supposed to result from a change in the habits of society, and particularly from the superior attention paid to cleanliness and ventilation in our cities, from the introduction of public sewers, &c. to which much importance has been attached, we must confess our apprehensions, that any seeds of disease which depend for their development upon filth, will not perish for want of a hot-bed in many districts of the larger cities of the three kingdoms.

A recent occurrence in Egypt forcibly inculcates the necessity of great caution in admitting, that in a country in which plague is known to have occurred, any changes have been effected, either in the soil or in the people, incompatible with its recurrence. Mr Edward W. Lane, in his Account of the Manners and Customs of the Modern Egyptians, written in Egypt during the years 1833, 1834, and 1835, says, "The climate of Upper Egypt is more healthy, though hotter, than that of Lower Egypt. The plague seldom ascends far above Cairo, the metropolis. It is most common in the marshy parts of the country near the Mediterranean. During the last ten years, the country having been better drained, and quarantine regulations adopted to prevent or guard against the introduction of this disease from other countries, very few plague cases have occurred, excepting in the parts above mentioned; and in those parts the pestilence has not been severe." But in a note Mr Lane adds, "This remark was written before the terrible plague of the present year (1835), which was certainly introduced from Turkey, and extended throughout the whole of Egypt, though its ravages were not great in the southern parts. It has destroyed not less than eighty thousand persons in Cairo, that is, one third of the population; and far more, I believe, than two hundred thousand in all Egypt."

If, from any of the circumstances alluded to, the British isles can be supposed to be free from the risk of the importation of plague-contagion, or of its diffusion in the event of importation, it is to be presumed that it does not enjoy this as an exclusive privilege, but must share it with other countries that are similarly circumstanced. It becomes necessary, therefore, to inquire in what countries, besides those immediately bordering on the Levant and Archipelago, we have occasion to believe that the plague has existed, or is capable of existing.

In the first place, of its liability to occur in the islands, and along the coasts of the more western portions of the Mediterranean, we presume no doubt can be entertained. In two of the Greek islands now under British dominion, viz. Corfu and Cephalonia, the plague occurred in 1816, in a form which left no room for doubt as to its real nature. In Italy, Malta, and the adjoining small island of Gozo, we have equally unquestionable examples of the occurrence of plague in recent times; witness that which occurred at Noja in the kingdom of Naples in 1816, and of which accounts have been published by Morea, Onofrio, and Schönberg; and that which occurred in Malta and Gozo in 1813, of which accounts have been given by Calvert, Faulkner, and Tully. Previously to 1813, Malta appears not to have been infected with the plague for upwards of a hundred and thirty years, that is, since 1675; a circumstance not undeserving the consideration of those who are disposed to consider non-occurrence as implying impossibility of occurrence.

In Sicily, we are not aware of the plague having appeared in an epidemical form since the year 1743, when it raged at Messina.

Along the African coast we have accounts of the occurrence of the plague at Tunis in 1818, 1819, and 1820, by Passeri; and of its occurrence so far to the west as Tangier in 1818 and 1819, an account has been published by Graberg di Hemso.

Of the plague-epidemics that have occurred on the northern shores of the western portion of the Mediterranean, that of which we possess the most circumstantial account is the epidemic of Marseilles in 1720. The descriptions of that epidemic given in the works of Chicoyneau, and of Bertrand and Michel, leave, we conceive, not the smallest room for doubt as to the disease having been genuine or Levant plague.

Of the extension of the plague from Turkey into more northern latitudes, numerous examples might be adduced. Between the years 1702 and 1711, it advanced by a gradual but steady course through the different provinces of Poland and Prussia to Dantzig, and from thence extended itself to Copenhagen. (See the accounts of this epidemic by Gottwald, Chamberlayne.) Again, in the year 1769 and 1770, when the Russians and Turks were engaged in warfare, the plague passed from the Turkish confines through some of the Polish provinces, and thence into the Russian territories, and ultimately reached the city of Moscow. (De Mertens, Orræus, Samoilowitz.)

It has been generally considered as a well-established fact in regard to the plague, that it had not been seen beyond a certain degree of eastern longitude, Mecca being the limit that has usually been assigned to its extension in that direction. This fact has been supposed to confirm and to be explained by the notion of its contagious poison being rendered innocuous by a certain degree of atmospheric temperature. From recent communications from India, however, there seems too much reason to apprehend that the plague has at length made its appearance on the confines of the north-western district of Hindustan. The only accounts of the epidemic which has excited these apprehensions that we have yet had an opportunity of perusing, are contained in the first three numbers of the Quarterly Journal of the Calcutta Medical and Physical Society, published between the 1st January and the 21st July 1837. We are unable to lay extracts before our readers, but we may refer to the communications of Mr Maclean, Dr Irvine, and Dr Keir, therein contained, as leaving little room to doubt that the epidemic in question was true plague, though not in its most aggravated form. (L. L. L. L.)

PLAIN, or PLANE, in general, an appellation given to whatever is smooth and even, or simple, obvious, and easy to be understood; and, consequently, stands opposed to rough, enriched, or laboured.

A plain figure, in *Geometry*, is an uniform surface, from every point of the perimeter of which right lines may be drawn to every other point in the same. A plain angle is one contained under two lines or surfaces, in contradistinction to a solid angle. See ANGLE and GEOMETRY. The doctrine of plain triangles, as those included under three right lines, is termed *plain trigonometry*. See the article TRIGONOMETRY.

PLAN, in general, denotes the representation of something drawn upon a plane, such as maps, charts, ichnographies, and the like. The term *plan*, however, is particularly used for a draught of a building, such as it appears, or is intended to appear, on the ground, showing the extent, division, and distribution of its area or ground-plot into apartments, rooms, passages, &c. A geometrical plan is that in which the solid and vacant parts are represented in their natural proportions. The raised plan of a building is the same with what is otherwise called an *elevation* or *orthography*. A perspective plan is that exhibited by degradations or diminutions, according to the rules of perspective.

PLANE, in *Geometry*, denotes a plain surface, or one that lies evenly between its bounding lines; and as a right line is the shortest extension from one point to another, so a plane surface is the shortest extension from one line to another.

In astronomy, conic sections, &c. the term *plane* is frequently used for an imaginary surface, supposed to cut and pass through solid bodies; and on this foundation is built the whole doctrine of conic sections. In mechanics, planes are either horizontal, that is, parallel to the horizon, or inclined thereto. The determining how far any given plane deviates from an horizontal line, makes the whole business of levelling. In optics, the planes of reflection and refraction are those drawn through the incident and reflected or refracted rays. In perspective we meet with the perspective plane, which is supposed to be pellucid, and perpendicular to the horizon; the horizontal plane, supposed to pass through the spectator's eye, parallel to the horizon; and the geometrical plane, likewise parallel to the horizon, in which the object to be represented is supposed to be placed.

The plane of projection in the stereographic projection of the sphere, is that on which the projection is made, corresponding to the perspective plane.

PLANE, in joinery, an edged tool or instrument for paring and shaving wood smooth. It consists of a piece of wood very smooth at bottom, as a stock or shaft, in the midst of which is an aperture, through which passes a steel edge, or chisel, placed obliquely; and this being very sharp, takes off the inequalities of the wood along which it slides.

PLANET, a celestial body, revolving round the sun as a centre, and continually changing its position with respect to the fixed stars; whence the name *planet*, which is a Greek word signifying "wanderer." See ASTRONOMY.

PLANETARIUM, an astronomical machine, so called from its representing the motions and orbits of the planets, agreeably to the Copernican system.

PLANETARY DAYS. Amongst the ancients, the week was shared among the seven planets, each having its own day. This we learn from Dion Cassius, and also from Plutarch (*Sympos.* lib. iv. q. 7). Herodotus adds, that it was the Egyptians who first discovered what god, that is, what planet, presided over each day; for amongst this people the planets were directors. And hence it is that in most European languages the days of the week are still denominated from the planets.

PLANETARY *Years*, the periods of time in which the several planets make their revolutions round the sun or earth.

As from the proper revolution of the sun the solar year takes its origin, so from the proper revolutions of the rest of the planets about the earth, several sorts of years arise; such are the Saturnian year, which is defined by twenty-nine Egyptian years, 174 hours, fifty-eight minutes, equivalent in a round number to thirty solar years; the Jovial year, containing 317 days, fourteen hours, fifty-nine minutes; and the Martial year, containing 321 days, twenty-three hours, thirty-one minutes. With respect to Venus and Mercury, as their years, when judged of with regard to the earth, are almost equal to the solar year, so they are more usually estimated from the sun, the true centre of their motions; in which case the former is equal to 224 days, sixteen hours, forty minutes, and the latter to eighty-seven days, twenty-three hours, fourteen minutes.

PLANIMETRY, that part of geometry which considers lines and plain figures, without regard to their height or depth.

PLANISPHERE signifies a projection of the sphere and its various circles upon a plane; in which sense maps, on which are exhibited the meridians and other circles of the sphere, are planispheres.

PLANT is defined to be an inorganical body, destitute of sense and spontaneous motion, adhering to another body in such a manner as to draw from it its nourishment, and having a power of propagating itself by seeds. See ANATOMY VEGETABLE, BOTANY, PHYSICAL GEOGRAPHY, and VEGETABLE PHYSIOLOGY.

PLANTAGENET, the surname of the kings of England from Henry II. to Richard III. inclusive. Antiquaries are much at a loss to account for the origin of this name; the best derivation they can find for it being, that Fulk, the first Earl of Anjou of that name, stung with remorse for some wicked action, went, as a work of atonement, in pilgrimage to Jerusalem, where, being soundly scourged with broom twigs, which grew plentifully on the spot, he afterwards took the surname of *Plantagenet*, which was retained by his posterity.

PLANTERSHIP, in a general sense, is the business of a planter. In the West Indies, plantership denotes the management of a sugar plantation, including not only the cultivation of the cane, but the care of the various processes for the extraction of the sugar, together with the making of sugar-spirits.

PLANTING.

Planting, or the culture of trees, is a branch of agriculture necessarily of much more recent date than either the culture of grain and herbage plants, or the breeding and rearing of cattle. The culture of those plants which in every country supply the food of mankind, whether directly, or by nourishing the domestic animals used for food by man, must have exclusively occupied his attention for many ages; whilst the timber which was employed in houses, ships, and machines, or for fuel, was found in the native woods. Hence, though we hear of the culture of fruit-trees, and occasionally also of ornamental trees and shrubs, amongst the Egyptians, Greeks, and Romans, the cultivation of timber-trees on a large scale by art only took place in modern times. In the days of Charlemagne, the greater part of France and Germany was covered with immense forests; and one of the benefits conferred on France by that prince, was the rooting up of portions of these forests here and there throughout the country, and substituting in their room orchards or vineyards. Artificial plantations appear to have been formed in Germany sooner than in any other country, and apparently as early as the fifteenth century. In Britain they took place, though but sparingly, nearly a century afterwards. Planting, however, was by no means general in England till the beginning of the seventeenth century, when, in consequence of the extensive transfers of property which took place in the preceding century, on the seizure of the church-lands by Henry VIII., much timber was sold by the new owners, in order to make good their payments. The quantity of timber thus thrown into the market lowered its price considerably, insomuch, as Hollingshed informs us, that the builders of cottages, who had formerly employed willow, and other cheap and common woods, now built them of as good oak as their lords. The demand for timber thus constantly increasing, and a demand for an extended surface of farming land going on at the same time, the natural forests became everywhere greatly circumscribed, till at last timber for naval purposes and house-building began to be imported, and the proprietors of land to think, first of protecting their native woods from the inroads of cattle; afterwards of enclosing pieces of waste ground, and allowing them to become covered with young trees from seeds carried thither by the wind or other accidental circumstances; and ultimately of sowing acorns and mast in such enclosures, or of filling them with young plants collected in the woods; a practice which exists in Sussex, and some other parts of England, even at the present day. Planting received a great stimulus in Britain soon after the breaking out of the late general war, partly in consequence of a real or supposed scarcity of timber fit for naval purposes, and partly owing to the high price to which the article for general use rose, in consequence of the increased expense of obtaining supplies from other countries. Since the peace, the rage for planting, with a view to profit, has subsided; but there is still a universal taste for cultivating trees and shrubs, with a combined view to ornament and use; and there is also an increased and increasing taste for the introduction of trees and shrubs from foreign countries.

Having in this slight manner noticed the origin of planting, we shall next give a brief outline of its present practice in Britain; noticing in succession: 1. A general view of the different properties possessed by trees; 2. selections suitable for different purposes; 3. the nursery culture of trees; and, 4. the culture of trees in plantations.

It is necessary to premise, that in this article we confine ourselves entirely to trees which are well known in Britain, and quite hardy; and to the formation of such plantations as are made with a view to their timber-produce. Fruit-trees and fruit-shrubs, flowering shrubs of every kind, and ornamental plantations, we consider as belonging to gardening, and as already disposed of under the article Horticulture.

I.—*General View of the different Properties possessed by Trees which may be cultivated in Britain.*

The sort of trees which it is desirable to plant, is necessarily the first point which a proprietor will take into consideration before he commences a plantation. Trees differ from one another in many particulars: in magnitude; in slowness or rapidity of growth; in their suitableness for poor soils or rich soils, moist grounds or dry grounds, elevated exposed situations, or low and sheltered plains; in the texture, colour, and durability of their timber; in their delicacy or hardiness in any given climate; in their being difficult or easy to propagate and rear; in retaining their leaves all the year, or dropping them every autumn; in producing showy flowers or fruits; and in a great variety of other particulars. In regard to magnitude, those trees which, in the latitude of Britain, and in the same parallels of latitude throughout the northern hemisphere, attain the greatest height, are the spruce and silver fir, the larch, and the Scotch pine; and these also are the trees which, in most parts of Britain, produce the greatest quantity of timber in their trunks relatively to that contained in their branches, and that in the shortest time. The poplar, the willow, and some species of elm, are rapid-growing trees, and produce a great bulk of head in a short period; but the timber of these trees is not all contained in one straight trunk, as in the case of the pines and firs, a considerable portion of it being distributed among the branches. Hence, where the speedy production of timber is the main object of planting, the pines and firs above mentioned are decidedly the trees that ought to be preferred. The production of timber, however, is not always the sole object of planting. Effect, or, in other words, the production of the appearance of woodiness on an estate, is perhaps oftener the object than mere timber. For this purpose the Scotch and English elms, the white, black, and black Italian poplars, the Huntingdon willow, and in some situations the birch, and in others, such as on the sea-shore, the sycamore, are the most desirable trees. Where the object is to clothe a sterile surface of dry sand, the birch and the Scotch pine are among the best trees that we have; and if the situation be exposed to the sea-breeze, the common and the Norway maple may be substituted for the birch and the pine; and, in the warmer parts of the island, the evergreen oak. For moist soils which cannot be drained, there are trees that have the remarkable property of sending their horizontal roots along the surface of the ground; among these are the white, the trembling, and the Ontario poplars; and, for the marshes of the warmer parts of the island, the deciduous cypress. There are trees which will grow near water, in situations where their roots can enter into it, but which will not grow in undrained soil, such as the different species of willow, and most of the poplars. It is a remarkable fact, that there is no tree in any part of the world which is truly aquatic; that is, which will spring up from the bottom of a pond or river. Had there been such trees created, there could then have been neither rivers nor lakes, and the whole of the terrestrial globe must necessarily have been either in a state of marsh or mountain.

In general it may be observed, that trees are not so absolute in their choice of soils as for each species to require one of a different nature; on the contrary, on almost any kind of soil not beyond the average in point of moisture, dryness, or tenacity, all the known species of trees and shrubs may be grown to a tolerably mature size and age. In some soils, however, they will thrive better than in others; and the timber produced generally varies in quality according to the soil. Thus a rich soil, while it contributes to the rapid growth of the pine and fir tribe, renders their timber less durable; and the same law holds good, more or less, with regard to every other species of tree.

The influence of climate on trees is incomparably greater than that of soil; for, whilst any tree may be said to grow on any soil, every tree may be said to have its particular climate; that is, a climate in which, the soil and other circumstances being suitable, it will attain its greatest bulk, and its timber endure the longest. Hence, when we take the geographical and physical range of any particular species of tree, the oak, for example, we shall find that there is what may be called a central climate, where, when on suitable soil, it attains its largest size; and that as it recedes from this climate, whether by latitude or elevation, either into one which is colder, or one that is hotter, it gradually diminishes in size, till it at last appears in the form of a shrub. Thus the common oak, which in Britain attains its largest size in Sussex and Hampshire, dwindles into a shrub on the mountains of the Highlands of Scotland, and also in the north of Africa; its degeneracy being occasioned in the one case by extreme cold, and in the other by extreme heat. Even within the range of the climate of Britain, the absolute character of trees, relatively to climate, is made obvious. The English or narrow-leaved elm, which is supposed to be a native of Asia Minor, and also of China, attains a large size in the neighbourhood of London, producing a great bulk of timber in a short period, and ripening its seeds; while north of York it does not thrive, and in Scotland it is considered only as an ornamental tree. The Lombardy poplar, which is known in the central counties of England to attain 100 feet in height in forty or fifty years, is nowhere seen of a timber-like size in Scotland; and it may be observed of the sweet chestnut and the walnut, that though they are grown both for their fruit and their timber in many parts of England, yet that they cannot be profitably employed for either purpose north of Newcastle.

Climate, relatively to trees, may be considered in regard to its average temperature throughout the year, to its temperature in summer and winter and in spring and autumn, and to its degree of atmospheric moisture. A high average temperature is no proof that a climate is suitable for trees; but a high summer temperature is suitable for many kinds, though the temperature of the winter may be very low. Thus the oaks and many other trees of North America, attaining there a prodigious size, survive a winter as cold as that of St Petersburg, where no native oaks of any kind are ever found; but the oaks of North America enjoy a very high temperature during summer, which rapidly develops their foliage and young shoots, and fully matures the latter, so as to enable them to withstand the most rigorous frosts of winter. In England the average temperature of the year is as great as that of the oak countries of the United States; but our summers are comparatively cold, moist, and gloomy; and though our winters are so much milder than those of America, yet the spongy, unripened, young shoots are always more or less injured by the frost. Another disadvantage of a country having a mild winter is, that the trees of those countries which have a very severe winter come into leaf earlier in the spring than the indigenous trees of the mild climate; and frosts being more or less prevalent at that season, they are proportionably liable to injury from that cause.

Evergreen trees form a very important division of the ligneous kingdom; and of these there are two classes, very distinct relatively to climate and temperature. The first of these classes comprises the needle-leaved trees, such as the pine and fir tribe, which will endure a degree of cold as great as that in which any deciduous tree will thrive; and the second, the broad-leaved evergreen trees, such as the holly, the box, the laurustinus, the laurel, the evergreen oak, the cork-tree, and the evergreen mangolia, all of which are trees of comparatively mild climates, and which are always found in a natural state on islands, or on continents at low elevations, and at no great distance from the sea: hence the very considerable number of evergreen trees which will endure the open air in Britain, compared with those which stand through the winter in the same parallel of latitude on the continent.

Of the trees cultivated in Great Britain, only a small proportion are indigenous. A considerable number are natives of other parts of Europe, and about two thirds of the whole are from North America. Of these North American trees there is scarcely one that is worth cultivating in Britain for its timber; and the reason seems to be, chiefly, that our climate is not sufficiently hot and light in summer to bring that timber to maturity. The truly useful timber-trees of Britain are those which are indigenous, such as the oak, the ash, the broad-leaved elm, the Scotch pine, &c.; or those which are found in the same hemisphere and in the same parallels of latitude, such as the larch, the spruce fir, the silver fir, &c. Of all the trees which are cultivated in Europe, that which is most to be depended on for the strength and durability of its timber is the common oak; and next, and perhaps equal to it, is the larch. The trunk of the oak-tree, when freed from the soft or outer wood, and thoroughly seasoned by exposure to the atmosphere, will endure an unknown period of time in buildings and machines; and, even when split up into thin laminæ, and put up in the open air as fencing, without any painting or other preparation, it has been known to last for upwards of a century. The common European oak is found to be more durable as timber than any of the American oaks, even when grown in America, unless we except the live oak; and there is perhaps no timber in the world equal to it for ship-building, excepting the teak-wood of India. The most generally useful timber grown in Britain is the Scotch pine; but as this timber is also imported from the north of Europe, and a substitute for it from North America in great quantities, it is not planted in Britain nearly so extensively as it otherwise would be. The timber of the larch is undoubtedly of greater durability than that of the Scotch pine; but being apt to warp, and not being so easily worked, it is less convenient for the purposes of house-carpentry and joinery. The timber of the common ash is valuable in the construction of agricultural instruments and machines, and it is one of the few woods which are almost as valuable when young as when of mature age. The wood of the broad-leaved elm is strong and durable, but that of the English and Dutch elms is much less so. The wood of the poplar, and that of the willow, when exposed to constant atmospherical changes, speedily decay; but when thoroughly seasoned, and afterwards kept perfectly dry, they will last for centuries. In general, it may be observed, that every description of timber, when at maturity, if thoroughly seasoned, and preserved in an atmosphere tolerably uniform in point of dryness, will last a long period.

The great majority of trees which are planted in Britain may be considered as ornamental; for though the timber of all of them is more or less useful, yet, if the mere production of timber were the main object of planting, all trees except the oak, the larch, the Scotch pine, and two or three others, would be rejected, either on account of their slow growth, or of the inferior quality of the timber which they produce in our climate. Trees may be considered as ornamental, from their general shape, from their foliage, from their flowers or fruit, or from their rarity. In order that the shapes of trees may be displayed to advantage, it is necessary that they should stand singly; and when this is the case with some species of trees, such, for example, as the different species of the pine and fir tribe, their shapes become strikingly different from what they are when grown in masses. The Scotch pine, when drawn up in close forests, produces a clean, straight trunk, free from branches for the greater part of its height; but when by chance or design it stands singly, it throws out gigantic branches on every side, and becomes one of the most irregular and picturesque-headed of trees. But of all the trees which assume ornamental shapes in consequence of standing singly or nearly so, the most remarkable is the cedar of Lebanon. When this tree is grown in masses, it shoots up with a straight, clean trunk, and terminates in a small, spiry top; but when planted alone, and allowed to spread its branches on every side, it throws out its gigantic arms in successive tiers, and forms an irregular pyramidal mass, unequalled for grandeur, singularity, and picturesque beauty, by any other tree of the temperate regions of either hemisphere. All trees indeed become comparatively the same naked poles with scanty tops when grown in masses, and all assume irregular and picturesque forms when grown singly. Hence, whenever trees are grown chiefly for the purpose of displaying their shapes, they ought to be placed at such a distance from each other as that their branches may not touch; which in practice is effected by scattering them in groups in parks or pleasure-grounds, or planting them in hedgerows. Trees which are valued as ornamental chiefly for their foliage, fruit, or flowers, will obviously display these to the best advantage when standing singly; but for such an object isolation is much less necessary, as the ornamental foliage will be displayed even when the plantation is in masses, and seen at a distance; and the flowers and fruits by planting the trees in the margins of plantations of other sorts.

II.—*Selections of Trees for particular purposes.*

The object of the preceding remarks is to communicate some general ideas on the subject of selection, and on the properties of particular species; and we shall next pursue the same subject more in detail, by giving the names of the principal trees deserving of culture in Britain, thrown into groups characterized by some property common to the whole.

Needle-leaved or Resinous Trees are characterized by straight erect trunks, regularly furnished with branches in tiers, which never, except under particular circumstances, acquire the size of timber. They never send up shoots from the collar or stool when cut over by the surface. The leaves are narrow, or needle-shaped, without veins, and they are evergreen. The seeds are produced in cones, and the whole plant is more or less resinous. They belong to the Gymnosperms of the natural system, which form an order intermediate between the Dicotyledoneæ, and the Monocotyledoneæ.

Larix Europæa, *Dec.*, is the most valuable species for its timber, which is of great durability, both in its young and mature state. Young larches, five feet or six feet high, and the spray of larch-trees of any age, last a very long period, when intertwined with larch stakes, so as to form a dead fence. Young trees from ten feet to fifteen feet in height are found, in the neighbourhood of Farnham and other places, to form the most durable hop-poles; and the durability of the mature timber, in every department, both in civil and naval architecture, has been placed beyond all doubt, by the experience of John duke of Atholl, as recorded in the Transactions of the Highland Society of Scotland, vol. xi. p. 165; and Loudon's *Arboretum Britannicum*, vol. iv. p. 2387. The bark of the larch is also of considerable value in tanning; and the leaves being deciduous, the tree is more favourable to the growth of grass under its shade, than any other species of pine or fir. The larch is readily increased by seeds which are ripened in abundance in Britain; and it prospers best in cool, argillaceous soil, moist rather than dry, and placed at a considerable elevation above the level of the sea. The larch is subject to various diseases, and, in certain soils, to the decay of the heart-wood; but very little is known at present, either of the cause of these diseases, or of their prevention or cure. The larch cultivated in Britain is a native of the Tyrol, and of the Alps of Switzerland; but there are some other species or varieties, natives of Siberia and North America, which, however, are considered as scarcely worth culture as forest-trees.

The Scotch pine, Pinus sylvestris, *L.*, is, next to the larch, the most valuable needle-leaved tree grown in Britain. Its timber forms the yellow deal of the Baltic and Norway; and it is unequalled by any species of pine or fir timber contained in any other part of Europe, or North America. The best Scotch-pine timber grown in Britain is produced in the native Highland forests; but there is reason to believe that artificial plantations, on soils and situations as nearly similar as practicable, would produce timber of nearly equal value. It has been the practice for many years past to decry the Scotch pine grown in Britain as a timber-tree; and as we have now no difficulty in importing deal from the north of Europe, this condemnation has been assented to by many without due consideration. If, however, we could import no pine or fir deal from any other country, and were obliged to grow it ourselves, we would ask where is the tree that would produce it in so short a time, and of so good a quality, as the Scotch pine? This tree is readily increased from seeds, which, unfortunately, as is the case with several other trees, are produced in the greatest abundance on stunted trees, or, at all events, on trees not remarkable for their large size, or the durability of their timber. Hence it becomes desirable to select the seeds from the best varieties, and this is now done systematically by the principal Scotch nurserymen. The Highland variety, with horizontal branches, P. sylvestris horizontalis, *Arb. Brit.*, is the variety at present of highest repute. The Scotch pine is a native of the continent of Europe, but not of any part of America.

The spruce fir, Abies excelsa, *Dec.*, is, as a British timber-tree, next in value to the Scotch pine. The young plants and the spray are almost as durable as those of the larch; the trunk grows straighter, more erect and slender, than in that tree, and when used with the bark on, as poles or as fence-wood, it is equally durable. The spruce makes much better hop-poles than the larch; but as the trunk of full-grown trees seldom attains a diameter of above one or two feet at the ground, even in countries where it is a native, the trunk can very seldom be profitably sawn up into boards. The great value of the tree is for poles of every kind, from those fit for the hop, up to the masts for the smaller ships. In most parts of Europe, all the poles used in the scaffolding employed in erecting buildings are formed of this tree. The spruce fir ripens seeds abundantly in Britain, from which plants are as readily raised as in the case of the Scotch pine and the larch. It prefers a soft soil, rather moist, and only attains a great height in sheltered situations; but it will grow to a size fit for hop-poles or fencing in a short time, and anywhere. Like the Scotch pine, it is subject to few diseases. The spruce fir is a native of the north of Germany, Sweden, Russia, and Norway, but not of Britain or of North America. There are three or four species of spruce natives of the latter country, but they are of no value as timber-trees.

The pinaster, Pinus Pinaster, *Ait.*, is by no means adapted for general culture in Britain, and therefore scarcely merits to be ranked among our needle-leaved timber-trees. In some parts of England, however, particularly in Norfolk, considerable plantations of this tree have been raised; and it is found in deep sandy soil to produce a considerable bulk of timber in a short time. It has also the advantage of thriving better when exposed to the sea-breeze than any other pine or fir. The wood is not so durable as that of the Scotch pine; but it is of the same colour, and may be employed in the joinery of ordinary apartments. In general, however, it is by no means sufficiently strong for the roofing, joists, and other carpentry of dwelling-houses. A great use of the tree in France, and particularly in the neighbourhood of Bordeaux, where it is extensively grown on the sandy wastes, is for the production of resin, tar, and pitch, which are obtained by incisions made in the trunk, and by subjecting the wood to the action of fire. Seeds of this tree are ripened in England; but they may be obtained in any quantity, at a very moderate rate, from Bordeaux. The young plants require more care in transplanting than those of most other pines and firs, being furnished with a stronger tap-root than any of them. The pinaster is a native of the south of Europe and north of Asia, but not of America. It has been introduced, however, into most countries, probably from the large size and handsome appearance of the cones. Accordingly, specimens of this tree have been sent home from China, New Zealand, St Helena, North America, &c.; and the produce of the seeds from these places are commonly, but improperly, treated by nurserymen as varieties.

The silver fir, Picea pectinata, *Arb. Brit.*, in favourable soils and situations produces a great bulk of timber in a comparatively short period; but the timber is much less strong and durable than that of either the spruce fir or the Scotch pine. The tree is of slow growth for the first ten or twelve years of its existence, and the leading shoot is at that age very apt to be injured by spring frosts; nevertheless, even in the north and west of Scotland it has been known to attain to the height of 100 feet in sixty or seventy years. The timber is white, and makes excellent flooring for bed-rooms. The tree ripens seeds in Britain, though more sparingly than the spruce fir, and plants are easily raised. It is in general healthy, though the points of the shoots are occasionally destroyed by frost or by insects. The silver fir is a native of Central Germany, and of the Alps of Italy and Spain; but of no other country. There are other species of Picea, natives of North America and Nepaul; but relatively to Britain they can only be considered as ornamental trees.

Other needle-leaved trees might be enumerated as attaining a timber-like size in the climate of England; but there is not one of them that we think can be ranked in value along with those already mentioned as timber-trees. Of the American pines, that of which we have had most experience in this country is the Weymouth pine, Pinus Strobus, *L.*, which furnishes the white pine-wood of American commerce; but this wood, grown in any given situation in Britain, is far inferior to that of the Scotch pine grown in the same locality; and there are only a few situations in England where the Weymouth pine will produce the same bulk of timber as the Scotch pine in the same period. The other American pines, as timber-trees adapted for Britain, scarcely deserve notice. Pinus tæda, serotina, and rigida, have attained a timber size in a few places in England; but the time they have required to do this, even under the most favourable circumstances, precludes the hope of their ever becoming British timber-trees. Several Californian species of pine have recently been introduced; but half a century will be required to enable us to judge of their suitableness for this country. The Californian spruce fir, Abies Douglasii, is the most promising needle-leaved tree that has been introduced from that country; but it remains to be proved whether we shall ever be able to rank it with the common spruce. Of Nepaul pines there are two species, P. excelsa and P. Lambertiana, which resemble the Weymouth pine; and there is a spruce fir, Abies Smithiana, *Arb. Brit.*, A. Morinda, *Hort.*, which promises to be as hardy as the Norway spruce; but the other pines and firs of the Himalayas are all rather tender. The cedar of Lebanon, if planted in masses, like the larch or the Scotch pine, would, in good free soil, produce abundance of timber, but of far inferior strength and durability to what the Scotch pine would produce similarly treated. However ornamental, therefore, this tree may be, it cannot be recommended as fit to be cultivated for its timber. There are some European pines and firs which deserve to be noticed, as possibly containing some trees among them that might be cultivated as timber. Among these are the Corsican pine, Pinus laricio, *Poir.*, including several varieties, among which, as we think, may be reckoned the black pine of Austria, Pinus Austriaca, *Höss*, as well as the Pyrenean pine, Pinus Pyrenaica, *La Peyrouse*, P. Hispanica, *Cook.* All these species or varieties appear to thrive in the climate of London; and there is a Corsican pine in the arboretum at Kew which is upwards of eighty feet high. Whether the rate of growth, and the strength and durability of the timber, will ultimately prove equal to that of the Scotch pine, appears to us doubtful. We think, however, that in point of bulk of timber, the Corsican pine would equal the Pinaster. The Cembrian pine, P. Cembra, *L.*, of which there are two varieties, one a native of Switzerland and the other of Siberia, grows as rapidly even in Scotland as it does in its native localities; but it is of extremely slow growth everywhere, and not worth cultivating as a timber-tree. Specimens in the climate of London, which have been nearly 100 years planted, have trunks only forty or fifty feet high, and from a foot to eighteen inches in diameter at the ground. The yew-tree, Taxas baccata, *L.*, though it attains its full perfection in this country, being indigenous, yet, from its slow growth, and the little demand for its timber, it cannot be recommended to the planter whose main object is profit. The arbor vitæ, evergreen cypress, deciduous cypress, and juniper, all belong to the needle-leaved division of trees; but none of them are worth cultivation with a view to profit.

Broad-leaved Trees, in contradistinction to needle-leaved, are classed, according to their timber, in two subdivisions, hard-wooded trees, and soft-wooded trees. They are characterized by large trunks and widely-spreading woody branches, and broad leaves with branching veins; they send up shoots from the collar or stool when cut over by the ground; and they are deciduous. They belong to the Dicotyledoneæ of the natural system.

The *hard-wooded Timber-trees of Britain* are characterized by the comparative hardness and durability of their wood, and consist chiefly of the oak, ash, elm, beech, sweet chestnut, walnut, and locust or false acacia.

The British oak may be considered as including two species or subspecies, the stalked fruited, or most common oak, Quercus Robur pedunculata, *Arb. Brit.*, and the stalkless fruited, or less common oak, Quercus Robur sessiliflora, *Arb. Brit.* The latter species or subspecies is found to grow more erect and more rapidly than the other, more particularly if the soil be good and deep. The two sorts are found indiscriminately mixed together in many parts of England, as in Woburn Park, Bedfordshire, and in various parts of Sussex; in other places one species exclusively prevails, as at Tiberton Park, near Hereford, where there are some of the largest oaks in England, on a deep, loamy soil, and almost all Q. R. sessiliflora. At Welbeck, in Nottinghamshire, on the other hand, there are a great many oaks, almost exclusively Q. R. pedunculata. In all the places mentioned, the trees are the remains of native forests. Though the wood of the oak is the strongest and most durable of that of all British timber-trees, the tree is not always that which the planter would make choice of with a view to profit, on account of the slowness of its growth. It has, however, this advantage, that as it bears a higher price than any other British timber, so it will pay better at a distance from the market; and thus, while oak will pay after conveying it fifty or sixty miles to a seaport, elm will scarcely pay at half that distance, and the soft woods at still less. Oak plantations are also more valuable than others when in a young state, on account of the value of their bark. From the value of oak as ship-timber, the price of trees fit for that purpose is always considerable; though what is paid for the largest trunks employed in naval architecture will not remunerate any one for the number of years they must have stood on the ground. Accordingly we find that the governments both of France and England grow this description of timber exclusively in national forests. The wood of the oak has also the advantage of being applicable to a greater number of uses than that of most other trees. Houses, ships, furniture, and machines, may be formed almost entirely of oak, and consequently there is a ready sale for this kind of timber almost everywhere; hence the oak may be more planted in Britain than any other hard-wooded tree. It is easily raised from acorns, which ought to be collected from the tallest and handsomest trees. The British, or naval oak, as it may perhaps be more properly called, is a native of Britain and most parts of Europe, but not of Asia, Africa, or North America. There are several subordinate varieties, but none worth notice as timber-trees, excepting the kinds which we have noticed.

The ash, Fraxinus excelsior, *L.*, is in most parts of Britain next in value as a timber-tree to the oak. The wood is chiefly used in the manufacture of agricultural implements, such as ploughs, handles to spades, mattocks, handles to carpenters' implements, carts, waggons, threshing-machines, &c. Young ash-trees, and ash poles and suckers, are also much in demand for crate-ware, hoops, whip-handles, walking-sticks, and especially for hop-poles. Before the general introduction of cast iron in machinery, ash-wood was much more in demand than it is at present. The tree requires a good, deep, loamy soil, dry rather than moist; and a situation naturally sheltered, such as the steep banks of glens, rivers, or lakes. As the value of the timber depends chiefly on its toughness and elasticity, the tree is best grown in groves or masses, in consequence of which, where the soil is good, the growth is rapid, and the trunk is drawn up free from large side-branches. The tree is easily propagated from its seeds or keys. It is a native of Central Europe, but of no other part of the world. There are several species of ash natives of North America, and one or two of Europe; but these are of no value in this country, excepting as ornamental trees.

Of the elm there are two species, the English or narrow-leaved elm, Ulmus campestris, *L.*, and the Scotch or broad-leaved elm, Ulmus montana, *L.* Between these two species there are several varieties, or hybrids, such as the Dutch elm and the Huntingdon elm, the latter by far the most valuable timber-tree of the genus. The narrow-leaved elm can hardly be considered as a timber-tree in Scotland, but in the central districts of England its rapid growth, straight trunk, and ample spreading head, constitute it a magnificent tree; and the timber is useful for some important purposes in ship-building, as well as in the construction of machines and agricultural buildings. The Scotch elm is a hardy tree, of rapid growth; but, unless planted in masses, it seldom produces a straight handsome trunk. Its timber is much more durable than that of the English elm, or of any of the hybrids between the species. It was formerly much used in agricultural carpentry, in rural machinery, and in common household furniture. The Scotch elm produces abundance of seeds, which, if sown as soon as they are gathered, often come up the same year; but the English elm and the hybrids produce seeds very sparingly, and are almost always propagated by layers, or by grafting on the Scotch elm. One remarkable difference between the English and Scotch elms it may be useful to notice, viz. that the latter never throws up suckers from its roots; and it is therefore peculiarly valuable as a stock for the English elm, and for those varieties or hybrids between the species which do throw up suckers. There are some other species and varieties of European elms, and several kinds of American elms, but none of them are deserving of culture in Britain as timber-trees.

The beech, Fagus sylvatica, *L.*, acquires a large size, particularly on chalky or sandy soils. It is a very handsome tree in every stage of its growth, but the timber is not remarkable either for strength or durability. It was formerly much used in mill-work and turnery; but its principal use at present is in the manufacture of chairs, bedsteads, and a variety of minor articles. It is a native of England, and of various parts of the continent of Europe. There are some varieties, particularly the purple beech; and there are one or two species natives of North America, but none of them deserve notice as timber-trees. It is propagated by its mast, which it produces plentifully in fine seasons.

The hornbeam, Carpinus Betulus, *L.*, is an indigenous tree, which attains the same height, but not the same diameter of trunk, as the beech, to which it bears a general resemblance, but is in every respect greatly inferior. It is propagated by its nuts, which it produces in abundance. This tree and the beech were formerly highly valued for making lofty hedges, on account of their retaining their leaves great part of the winter.

The sweet chestnut, Castanea vesca, *Gærtn.*, is generally ranked next to the beech as a timber-tree; but in that character it has little or no merit. The tree is magnificent in appearance, rivalling, when full grown, the British oak; but it differs essentially from that tree in its timber not increasing in value as it increases in age. In Britain, and also in France, it was formerly believed that the roofs of the oldest cathedrals, and of Westminster Hall and other buildings, were of chestnut; and it was thought, in consequence, that the tree had formerly been more abundant, both in Britain and on the Continent, than it is at present. Subsequent inquiry, however, proves all this to be a mistake; and Daubenton and various others have shown that the timber called chestnut in old buildings is referable to the chestnut oak, Quercus Robur sessiliflora, *Arb. Brit.* It is worthy of remark, that some of the ancient writers describe a grove of chestnuts as extending northwards from London, and abounding in wild beasts; and that the remains of the indigenous woods at Hampstead, in the Earl of Mansfield's grounds, are of the chestnut oak. The timber of the sweet chestnut, when not more than of forty or fifty years' growth, forms very durable posts for fences and gates; being, according to some, more durable in this capacity than oak itself; but whenever the trunk of the tree becomes of larger dimensions than six or eight inches in diameter, the timber is found to be shaky; and at eighteen inches or two feet in diameter it has already begun to decay at the heart. In a young state, when the stems are not above two inches in diameter at the ground, the chestnut is found to make durable hoops for casks and props for vines; and of a larger size it makes good hop-poles, though the stem tapers rather too much for that purpose. It is a native of Asia, the north of Africa, and of North America; and some think it a native of Britain. In the south of England, in fine seasons, it ripens abundance of fruit, from which plants are easily raised. There are a number of varieties, both in Britain and on the Continent, which are highly valued for the qualities of their fruit; but none of these, nor any of the American kinds, are worthy of being cultivated for their timber.

The common sycamore, Acer Pseudo-Platanus, *L.*, is a tree of the second rank, seldom attaining the height of any of those that have been hitherto mentioned. It has, however, the merit of withstanding the sea and mountain breezes better than most other timber-trees; and its wood is valued in turnery, and for a variety of minor purposes. It produces abundance of seeds, which, like those of the ash, are called keys, and it is easily raised in the nursery; but it does little good in plantations, unless the soil be good and tolerably dry. It will neither thrive on very stiff clays, nor on dry sands or chalks. There are several species of Acer, natives of Europe and North America; and that which comes nearest to A. Pseudo-Platanus, as a timber-tree, appears to be the A. obtusatum, *Arb. Brit.*, a native of Hungary and Calabria, but it has not yet been tried in plantations made with a view to profit. The Norway maple, A. platanöides, *L.*, is a hardy and very interesting tree; but neither it, nor any of the other species, either from America or Europe, seem to deserve cultivation for their timber. If we made any exception, it would be in favour of the common field-maple, Acer campestre, *L.*, which forms a very curious wood for the cabinet-maker.

The common birch, Betula alba, *L.*, is another tree of the second rank, which is worthy of culture in inferior soils and situations, more especially as coppice-wood. The spray, in some parts of the country, is sold to the besom-maker, and makes a valuable return. The tree seeds freely, and is in every stage of its progress easy of management. There are several species of birch, natives of North America, which attain the size of timber-trees, and all of them have been introduced into this country, and tried in British plantations; but there is not one of them which can be considered otherwise than as an ornamental object, or as one of botanical interest.

The false acacia, or locust, Robinia Pseud-Acacia, *L.*, may be placed amongst the timber-trees of the second rank. It is of unquestionable beauty, and much has been said of the value of its timber. When of a certain age, this is of great hardness and durability, and it lasts a long time as posts, or as trenails or wooden pins, for bolting together ships' timbers. For the latter purpose, however, iron and copper are now generally used, both in Europe and America. The false acacia has been much recommended by Cobbett and a host of other writers for hop-poles and props for vines; but though it has been extensively tried in England for the former purpose, it is now utterly neglected, being found rarely to grow straight and clean, and, when used, being much less durable than the ash.

Amongst hard-wooded trees of the third rank, the timber of which is of some use, are the mountain ash, Sorbus domestica, *L.*; the white beam-tree, Sorbus Aria, *L.*; the wild apple, wild pear, wild cherry, and wild plum, the hawthorn, the holly, the laburnum, and perhaps one or two others. We could hardly recommend a plantation to be made solely of any of these trees; but when a few are introduced by way of variety or ornament, it is useful to know that their timber is of some value. The laburnum, the holly, the yew (which last we have included under the needle-leaved trees), are by far the most valuable of the trees of the third rank. The heart-timber of the laburnum is almost as dark and hard as that of ebony, and that of the holly is of a beautiful white. The timber of the yew is veined, and its beauty may be increased by judicious staining. The roots of the thorn, the yew, and of most of the third-rate trees, are often beautifully veined, and employed in cabinet-making and veneering.

Soft-wooded Trees are distinguished by the comparative rapidity of their growth, and the softness of their wood, its whiteness, and its limited duration. The principal of these worth cultivating in Britain as timber-trees, are the poplar, the willow, the alder, the lime, and the horse-chestnut.

The poplar, Populus, *L.* There are several species of this tree, which well deserve culture with a view to their timber, where the soil is good and deep, and where the roots can reach water without being saturated by it. The white and gray poplars, Populus alba, *L.*, and P. canescens, *L.*, are hardy, of very rapid growth, attaining a height of thirty or forty feet in most parts of Britain in ten or twelve years, and producing a beautiful, smooth, compact, white timber, well adapted for flooring bed-rooms, and for a great many minor purposes, either in its native colour, or stained black in imitation of ebony. The black Italian poplar, P. monilifera, *Dec.*, is an equally rapid-growing tree with the white poplar, and produces a beautiful pale-yellow timber. The common black poplar, P. nigra, does not grow so rapidly as the last, and seldom produces a straight trunk; but its timber is homogeneous, of a yellowish white, and takes a fine dye. The aspen, or trembling poplar, P. tremula; and the Athenian poplar, P. Græca, are of slower growth than the white or black poplars, and they have a beautiful, smooth, homogeneous, white wood. There are a number of other species of poplar, chiefly natives of America, and the Lombardy poplar, which is a native of Persia; but none of these are worthy of being planted as timber-trees in the climate of Britain.

The white willow, Salix alba, *L.*, is a rapid-growing tree, and produces a great bulk of timber in a short period. The wood is white, soft, and sometimes slightly veined with blue. When kept dry, and well ventilated, it will last a long time, and has been found in buildings which have existed upwards of a hundred years, in a perfectly sound state. The Bedford willow, Salix Russelliana, *L.*, grows with about the same rapidity as the white or Huntingdon willow, and its timber is of the same quality. The crack-willow, Salix fragilis, *L.*, is a tree of a smaller size, but its timber is useful for a variety of purposes; and the bark of this, and of most of the other species, may be used in tanning. There are a great many species and varieties of willow natives of Europe, or of North America and Asia; but, excepting the three above mentioned, we do not consider any of them as worth cultivating for timber.

The alder, Betula Alnus, *L.*; Alnus glutinosa, *Dec.*, is an indigenous tree, of smaller size and much lower growth than the poplars, or tree-willows; but its timber is more valuable from being more compact, less liable to twist, and having a fine mahogany tinge. The tree is a native of Britain, and of most parts of Europe, on moist soils by rivers; and it is readily propagated by seeds. There are some other European species; and two, Alnus incana, and Alnus cordifolia (the latter lately introduced from Naples), may probably prove useful as timber-trees, as they both grow on dry soils; but, from the experience which has yet been had respecting them, they can only at present be recommended as ornamental.

The lime-tree, Tilia Europæa, *L.*, is a well-known soft-wooded tree, of some value for its timber, which is used by musical-instrument makers and carvers. It is a native of Europe, and is generally propagated by layers. The blossoms produce the whitest and most delicate honey in the world. There are some American lime-trees, but they scarcely attain the size of timber-trees in England.

The horse-chestnut, Æsculus Hippocastanum, *L.*, is a rapid-growing tree in good soil; but its timber is perhaps the least valuable of the class to which it belongs, as it has little strength, and, unless kept dry, is far from being durable; but it is useful for some husbandry purposes, such as linings to carts, wheel-barrows, &c.; and it takes a ready dye as a substitute for ebony.

The only soft-wooded trees that can be recommended for culture with a view to profit, are the white, gray, black Italian, and common black poplars, and the white and Bedford willows.

Hedge-trees and Shrubs.—Plants which are useful for forming hedges are of as great importance to the planter as those which are valuable for their timber. Almost all trees planted in rows, with the free admission of air and light on every side, will become clothed with branches from the ground upwards; and if these are occasionally cut in, they will form gigantic hedges, more or less compact; but some trees are much better adapted for this purpose than others; and among those of the first class, the best are the beech, the hornbeam, the elm, the lime, the Lombardy poplar, and the spruce fir. The best of the second class are perhaps the common birch, Sir Charles Wager's maple (Acer eriocarpum), and the evergreen oak; and the best of the third class are the common thorn, the crab, the sloe, the wild plum, the buckthorn, the barberry, the holly, and the yew. By far the best of these for British field-hedges is the common hawthorn, and the next best is the wild crab. The sloe or black thorn makes an excellent hedge; but it throws up so many suckers, that it requires constant attention to keep it within bounds. It forms, however, an excellent barrier for picturesque plantations, where it is allowed to spread itself in every direction. The holly, were it not for the slowness of its growth, would form the best of all hedges, both for gardens and fields, as its leaves are little liable to be injured by insects; and, being an evergreen, it neither harbours weeds nor vermin at its roots. Birds are also much less apt to build in it than they are in deciduous hedges. It has only two disadvantages that we are aware of, viz. the slowness of its growth, and its imperviousness to wind in the winter season. On this last account, when on damp clayey soil, it has a tendency to prevent the drying of arable lands in spring. Were holly hedges occasionally introduced among those of the common thorn, they would add very greatly to the beauty of the country in the winter season; and, on dry uplands, they would form excellent shelter for stock. The common furze sown on the top of a high bank forms an effective hedge in a short period, but it is of no great duration. On moist soils fences may be made for planting rows of willows or poplars, and in situations exposed to the sea-breeze the elder may be planted; but such fences can be hardly considered as hedges, from their want of compactness and density of foliage.

Trees and Shrubs suitable for Coppice-wood and Undergrowth.—One property required for all these plants is, that they should stole or spring up from the collar or stool when they are cut over; and the true undergrowths are only to be found among such shrubs as will grow under the shade of trees. There are a great many woody plants which may be cultivated as coppice-wood; indeed there are few of the broad-leaved trees and shrubs which will not answer for this purpose, but the locality must determine the preference. In soft, wet soils, the birch, the alder, and the apple-leaved willow, are amongst the most common and useful trees. In drier soils, the ash forms a most valuable coppice-wood, supplying handles for agricultural implements, stuff for hurdles, hoops, wattles, and a great many other useful articles. In good, deep, loamy soil, the oak forms an excellent underwood; and if the situation be at a distance from a market, it is by far the most valuable that can be employed, as the bark alone will produce a sufficient profit, and, from its portable nature, it can be sent to a greater distance than timber.

Ornamental Trees and Shrubs include by far the greater number of woody plants in cultivation; though many, perhaps the whole of them, produce wood which, when it can be obtained of sufficient size, may be applied to some useful purpose. As already observed, we exclude altogether from consideration in this article, flowering and fruit-bearing trees and shrubs. We also exclude all those that are rather delicate, or require particular kinds of soil; and shall confine ourselves to trees and shrubs which are considered ornamental from their general form, and which may be introduced into the margins of ordinary plantations in most parts of Britain. We shall arrange these under the heads of evergreen and deciduous.

Evergreen ornamental Trees and Shrubs.—The most ornamental of these, and one which will thrive in every part of Great Britain, is undoubtedly the cedar of Lebanon. It is somewhat delicate when young; but, if brought forward in pots, placed where it is finally to remain when of the height of eighteen inches or two feet, and carefully planted, and protected from cattle and vermin, it soon makes a vigorous growth, and becomes a handsome tree, even in the Highlands of Scotland. The seeds of the cedar of Lebanon, when left in the cones, retain their vitality for a number of years; the cones are sometimes imported from the Levant, but more generally obtained from English trees. Where proper care can be bestowed on the seeds and the soil, it would be an improvement to sow them where they are finally to remain; because the cedar, and all the pine and fir tribe, depending principally on their surface-roots, suffer more from confinement in a pot, or transplanting from the open nursery, than trees having powerful tap-roots. The Deodar cedar differs in general aspect from the cedar of Lebanon, in having foliage of a whitish or glaucous hue. It appears to be as hardy as the other, and will probably soon become as common. Cones are imported from the Himalaya Mountains, where the tree is indigenous; or it may be grafted on the common cedar, or raised from cuttings. All the pine and fir tribe may be described as highly ornamental, and a great many of them will endure the open air in the coldest parts of Britain. The Weymouth pine, Pinus Strobus, is a very hardy ornamental tree; and still more so is the Pinus Cembra, which is of slow and erect growth, and retains the beauty of youth longer than any other pine. The Pinus excelsa is a very hardy and very ornamental species, but it is at present rare. Pinus Banksiana, and P. inops, are curious and very ornamental species. Some of the Californian pines, particularly P. ponderosa and P. Sabiniana, appear to be quite hardy. Among the ornamental spruce firs may be mentioned Abies Smithiana (A. Morinda, *Hort.*), a native of the Himalayas, which closely resembles the common spruce, and is apparently as hardy; it is readily propagated by cuttings, and by herbaceous grafting on the common spruce; and the trees already planted will probably very soon produce cones. The largest tree of this species in Britain is probably that at Hopetoun House, near Edinburgh. The Douglas fir, Abies Douglasii, is a very handsome tree, apparently as hardy as the common spruce, but differing in the dark-green colour and somewhat two-rowed disposition of its leaves, from which it appears intermediate between the common spruce and the silver fir. It has already attained the height of eighteen or twenty feet in different parts of Britain, and has produced cones. The Cephalonian fir, Abies Cephalonica, *Arb. Brit*, is a very handsome tree of the same kind, and of recent introduction; and which, having withstood the winter of 1837–38, is probably hardy enough to become an ornamental British tree. It is very readily propagated by cuttings, and cones might doubtless be imported from Cephalonia. The black and white spruces of North America are well known ornaments in our shrubberies; and there are some Californian species, such as Abies

Menziesii, which will probably soon be added to their number. The hemlock spruce (Abies Canadensis, *Mich.*) is one of the most ornamental of fir-trees; it is very hardy, and ripens seeds in different parts of England. One of the finest specimens is at Strathfieldsaye, in Hampshire, the seat of the Duke of Wellington. Among the ornamental silver firs, the first in point of grandeur is the Picea Webbiana, *Arb. Brit.;* but, even in the climate of London, it suffers so much from the spring frosts, that it is doubtful whether it will ever become a very ornamental tree in England. Nevertheless, though the severe winter of 1837–38 seriously injured this tree, it did not kill it; and probably, as it increases in age, it may be later in protruding its young shoots, and thus be more likely to escape the spring frosts. Even the silver fir, which attains the height of 100 feet and upwards in many parts of Britain, is yet frequently injured by frosts during the first twenty years of its growth. Picea pichta Fraseri, and some other species and varieties, natives of Siberia or North America, are as hardy as the balm of Gilead fir, Picea balsama, *Arb. Brit.* The Chili pine, Araucaria imbricata, is a noble tree in its native country, and appears to be much hardier in the climate of Britain than has generally been imagined. Young plants which have been two or three years established in the open ground passed the severe winter of 1837–38 without any injury, which renders it not improbable that it may ultimately prove as hardy as the common cedar. The evergreen oak, Quercus Ilex, *L.*, is a hardy evergreen tree, of which there are several varieties. It is readily propagated from its acorns, which are ripened in abundance in this country, or may be imported from the Continent. It will thrive in any deep dry soil, and forms excellent hedges, or shelter to a dwelling-house. The cork-tree, Quercus Suber, *L.*, is of a corresponding character, but rather more tender. The holly, the common yew, the Irish yew, and the box-tree, are evergreens universally known and admired. They are perfectly hardy in every part of Britain, and deserve a place in every plantation.

The Portugal laurel and the common laurel form very ornamental trees, or large shrubs; and, from their glossy foliage, they are particularly beautiful in winter. The alaternus and the phillyrea form large bodies very ornamental. The arbor vitæ, of which there are two species, is very hardy, and forms a permanent fastigiate low tree. The red cedar, Juniperus Virginiana, *L.*, the Phœnician juniper, and some other species of juniper, are at once hardy and ornamental. The cedar of Goa, Cupressus lusitanica, *L.*, is a beautiful evergreen, with glaucous foliage, but somewhat tender; nevertheless, in Ireland it has attained a great size. The common cypress, Cupressus semper virens, *L.*, grows vigorously in the central districts of England, but scarcely thrives in the northern counties. The Arbutus is one of the handsomest of evergreens, and is admired for its flowers and fruit, no less than for its foliage and general form. There are several varieties and species which endure the open air in the climate of London, but which are found rather tender farther north. The sweet bay, Laurus nobilis, *L.*, forms a bushy low tree in the climate of London, and in the south of England has attained the height of sixty feet; but it suffered much from the severe winter of 1837–38, and may be considered, on the whole, as rather tender.

Sub-evergreens are trees which retain their leaves through the winter in a green state, and drop them late in spring, immediately before the development of the new leaves. The principal British trees of this description are certain varieties of the Turkey oak, and more especially the Fulham oak, and the Lucombe oak. These are trees of the first rank, and in the central districts of England become magnificent objects. Turner's oak, Quercus Turneri, is also sub-evergreen, and forms a handsome tree of the second size. Quercus virens, the live oak of America, forms a sub-evergreen tree in the climate of London, but farther north it is to be feared that it will be found rather tender.

The common privet, especially when cultivated in good soil, becomes a sub-evergreen bush, and, when trimmed to a single stem, a handsome small tree; and to it might be added some others, such as Cratægus Mexicana, Photinia serrulata, Berberis aristata, Aristotelia Macqui, and Cotoneaster frigida, affinis, acuminata, and nummularia, all of which are quite hardy in the climate of London, and also in Ireland, but rather tender in the north of England, and in some parts of Scotland.

Deciduous ornamental Trees and Shrubs.—We shall notice the hardiest of these in the order in which they occur in the natural system. Magnolia acuminata is perhaps the only species of Magnolia that can be considered truly hardy in most parts of Britain; and, from its large leaves, and curious greenish-blue flowers which afterwards change to yellow, it well deserves a place either on the lawn, or in the margin of plantations. M. cordata, tripetala, and conspicua, are quite hardy in moderate climates; but M. conspicua flowers so early that it is apt to be injured by spring frosts. The tulip tree, Liriodendron Tulipifera, *L.*, forms a tree of the first rank in the climate of London, and attains a considerable size in the milder parts of Scotland; for the beauty of its foliage, independently altogether of its flowers, it deserves a place in every collection. The Hungarian or white-leaved lime-tree, Tilia Europæa alba, *Arb. Brit.*, is a tree of the second rank, of very great beauty, and nearly as hardy as the common lime-tree. From the effect of its mass of white foliage among the green leaves of other trees, it becomes useful for breaking formal lines, directing attention to particular objects, or harmonizing white buildings with verdant scenery. The red-wooded and yellow-wooded lime-trees are very ornamental, and also the cut-leaved variety. The American limes are sufficiently hardy to attain the size of trees in the climate of London, and, from their leaves being much larger than those of the European limes, they are very ornamental. The maple, Acer, *L.*, is a genus which contains some of the finest ornamental trees that occur in British plantations. They are all valuable for coming early into leaf and early into flower, as well as for the many angled forms of their leaves, and the beauty of their buds. The variegated leaved varieties of the common sycamore form very ornamental objects, but, like all variegated leaved trees, their greatest beauty is in spring, when the leaves first expand. The variety with white striped leaves is well known, and is very generally planted; but the yellow-leaved variety, or Corstorphine plane, though by far the most beautiful, is scarcely known, except in the neighbourhood of the original tree. The purple-leaved variety is a very striking one, having the under surface of the leaves, more especially when they first come out in spring, of a dark purple. The hairy fruited, or Sir Charles Wager's maple, Acer eriocarpum, is a very elegantly shaped tree, with beautifully cut leaves, and conspicuous reddish flowers, which appear in February; it ought never to be omitted in plantations having the slightest pretensions to ornament. The red flowering or scarlet maple, A. rubrum, resembles the last tree in foliage; but its flowers are of a much darker red, and the tree is of less vigorous growth. In autumn the leaves die off of an intensely deep red, insomuch that the tree attracts attention even at the distance of a mile or two. Where it thrives, it may certainly be considered as the most ornamental of all the maples. A. Tataricum and spicatum are low trees, the first a native of Tartary, and the last of North America; they are remarkably hardy, come early into flower, and their keys and leaves die off of a fine yellow or red. The snake-barked maple, A. striatum, is a beautiful tree, whether we regard its leaves or its bark; it is a native of Pennsylvania, and therefore quite hardy in Britain. A. macrophyllum, the large-leaved maple, is a remarkably fine tree, with leaves sometimes nearly a foot in diameter; it appears to be as hardy as the common or the Norway maple, and its growth when young is very rapid; though, having been only lately introduced from North America, it is as yet scarcely known in Europe. The Norway maple, A. platanöides, is so hardy that it might almost be considered as a timber-tree; but being inferior in this respect to the common maple, it, and its different varieties, are more generally to be ranked as ornamental. The sugar maple, A. saccharinum, in Britain, is one of the most tender North American maples; it bears a close resemblance to the Norway maple, and, like it, its foliage dies off of a very rich yellow. A. obtusatum, a native of Hungary and of Calabria, is a remarkably fine vigorous-growing tree, bearing a considerable resemblance to the sycamore, Acer Pseudo-Platanus. A. Opalus is a very handsome small tree, with round, coriaceous leaves, finely cut at the edges; this tree is little known and seldom planted, though few objects are better adapted for a small lawn. The round plaited-leaved maple, A. circinatum, is a rare species from North America; but one of great beauty of foliage, and apparently quite hardy. A. Monspessulanum is a small tree of great beauty, and in some situations sub-evergreen. The common or field maple, A. campestre, is one of the hardiest and most beautiful of small British trees: the most ornamental tree of this species is the Austrian variety, A. campestre Austriacum, *Arb. Brit.*, which forms a beautiful single object on a lawn, and also very good garden hedges. The Negundo, or box-elder, Negundo fraxinifolium, *Dec.*, a native of North America, is a beautiful tree, with its leaves cut in the manner of those of the ash, and a fine, smooth, dark-green bark. The foliage, when it first appears, is of a fine yellow, and when mature it is of a pale green. It is a desirable object, as a single tree, or in the margin of plantations. The different species or varieties of the horse-chestnut are all trees remarkable for the beauty of their foliage, but more especially for that of their flowers. The common species is known to every one, but the scarlet and red flowered varieties, and the yellow and pale flowered kinds, all comparatively of recent introduction, only require to be seen to be ardently desired by all lovers of trees. The pavias, or smooth-fruited horse-chestnuts, are much smaller trees than the rough-fruited kinds, and they are all extremely beautiful. P. rubra, flava, discolor, hybrida, neglecta, macrocarpa, and macrostachya, deserve to be in every collection. Kœlreuteria paniculata, a native of China, is a hardy tree, very ornamental from its foliage as well as its flowers. There are fine specimens both in England and Ireland, yet the tree is not generally met with in pleasure-grounds. The toothache-tree, Xanthoxylum fraxineum, is a small tree or large shrub, a native of North America, hardy and ornamental both from its foliage and flowers. The same may be said of the shrubby trefoil, Ptelea trifoliata. The ailanto, Ailantus glandulosa, is a native of China, but perfectly hardy in most parts of England. It forms a stately tree of the first rank, with a straight trunk, ample head, and magnificent foliage, the leaves, which are compound, being sometimes three feet in length. In some parts of France it is planted as a timber-tree, and is found to thrive particularly well on chalky soils. The bladder-nut tree, Staphylea, *L.*, is a hardy bush, which may be trained to a very handsome low tree, ornamental from its foliage, its white flowers, and its curious bladder-like capsules. There are two species, S. trifoliata and S. pinnata, both deserving a place in the shrubbery. The spindle-tree, Euonymus, *L.*, is a genus of which there are several species, quite hardy, and singularly ornamental when in fruit. The common spindle-tree, E. Europæus, and the broad-leaved spindle-tree, E. latifolius, are the handsomest hardy species of the genus, and, when trained up to single trees on a deep loamy soil, with ample space, they form in autumn, when their capsules are ripe, objects altogether unique in the arboricultural world. Though these species are commonly seen as shrubs drawn up among others, or growing in hedges, and forming bushes perhaps not more than six or eight feet in height, yet, when properly treated, they will form trees thirty feet high, as may be seen in some of the London gardens, and even as far north as Forfarshire, where the spindle-tree produces a timber much sought after by coopers. The different varieties of the common holly are so well known for the beauty of their foliage, that the reader only requires to be reminded of them. The Minorca holly, Ilex balearica, and the opake-leaved holly, I. opaca, are very handsome kinds, which ought not to be forgotten. The winter-berry, Prinos, is a deciduous shrub, a native of North America, which, like the holly, produces fine scarlet berries, and retains them through the winter. There are several species, all quite hardy, and one or more of them deserve a place in every collection. Christ's thorn, Paliurus aculeatus, is a native of Asia, and is used as a hedge-plant in the north of Italy. It is altogether a most elegant bush or tree, there being something quite unique in its branches, bark, and thorns, which are very numerous; and in its leaves, flowers, and seeds. The buckthorn, Rhamnus, is a hardy genus of shrubs or low trees, of which there are many species; but we shall confine ourselves to those which are decidedly hardy. Rhamnus Alaternus is a well-known evergreen, of which there are varieties having broad and narrow leaves, and leaves blotched or variegated with yellow, and also with white. R. hybridus, a native of France, is a sub-evergreen, resembling the alaternus. R. catharticus, the purging buckthorn of Britain, and the white thorn of the modern Greeks, forms a very hardy and handsome small tree. R. alnifolius, alpinus, and frangula, are also very handsome small trees; and there are several other species which, if they can be procured, well deserve a place in the shrubbery. R. latifolius, a native of the Azores, is a very handsome kind, and quite hardy both in the gardens of London and Edinburgh. The different species of rhus are very hardy and very ornamental. R. Cotinus is a particularly interesting object when its seeds are ripe. R. typhina, viridiflora, and glabra, are curious from the stag's-horn appearance of the ends of the branches; and their leaves, before they drop, assume a fine yellow, rich scarlet, or dark-red hue. Sophora Japonica forms a splendid tree in the climate of London, and there is a pendulous-branched variety which is very ornamental. One property of this tree is, that in dry and warm seasons, when the leaves of most other trees become of a paler green than usual, those of this tree assume a darker hue. Virgilia lutea is a North American tree, with fine large foliage, hardy in most parts of Britain; and, in America, valued for the yellow colour of its wood. The laburnum has already been mentioned both as a useful and an ornamental tree. The purple laburnum is a hybrid between the Scotch laburnum and the Cytisus purpureus, of vigorous growth, but more curious than beautiful. Robinia viscosa is a variety of the false acacia, or locust-tree, with a glutinous bark, and flowers slightly tinged with pink. It is a beautiful object, both in foliage and when in blossom, and is as hardy as the common robinia or locust. There are a number of other varieties of Robinia pseud-acacia, and in particular the parasol-acacia, all of which are very ornamental. The rose-acacia, Robinia hispida, of which there are several varieties, is highly prized for its rose-coloured flowers. The Siberian pea-tree, Caragana arborescens, and a number of other varieties or species of Caragana, are all very ornamental, and quite hardy; and the same may be said of the salt-tree, Halimodendron, and of the different species of Colutea, or bladder-senna. The three-thorned Gleditschia, or honey-locust, Gleditschia, *L.*, is a genus of which there are seven species in cultivation in British nurseries, besides varieties. Some of the Gleditschias attain the size of trees of the first rank, and others are middle-sized or small trees; but they are all deserving of culture, on account of the beauty of their foliage, and their very remarkable spines. The Kentucky coffee-tree, Gymnocladus Canadensis, is a curious-looking object in winter; but in summer it is clothed with a magnificent foliage. It is a native of Canada, easily propagated by cuttings of the roots, and consequently hardy enough for any part of Great Britain; though, strange as it may appear, it is far from being common in collections. The Judas trees, Cercis Siliquastrum and Canadensis, are very handsome small trees, both when in leaf and in flower; the flowers have an agreeable acid, and they are used in Paris in salads, and fried in batter for fritters. The almond, the peach, the apricot, the plum, and the cherry, in their single or comparatively wild state, and also the varieties of these species having double flowers, are fine ornamental objects in plantations or on lawns, and are quite hardy. Cerasus semperflorens and serrulata, the Allsaint, and Chinese double-blossomed cherries, are very desirable ornamental trees. The perfumed cherry, Cerasus mahaleb, is a most valuable tree, coming early into flower, diffusing its odour in every direction, and soon afterwards becoming covered with berries, which are generally of a glossy black, but in some varieties yellow. The bird-cherry, Cerasus padus, is a native of the woods both of Scotland and Sweden, and one of the most ornamental of low trees when in flower. Its beautiful spikes of white blossoms are succeeded by black or red fruit, which is very ornamental while it remains on the tree, but when ripe is soon devoured by birds, by whom it is greedily sought after. The Cornwall bird-cherry, Cerasus padus rubra, and the pendulous branched bird-cherry, Cerasus padus bracteosa, are interesting varieties. C. Virginiana, serotina, and capollin, are species of bird-cherry resembling one another, surpassing the European bird-cherry in the smoothness and glossiness of their foliage, and equaling it in the beauty and profusion of their flowers. C. Virginiana is so hardy, and produces fruit in such abundance, that in some parts of England it may be considered as naturalized, having come up in the native copses from seeds carried thither by the birds from artificial plantations. There are about twenty other species of Cerasus, all quite hardy; and though some of them are of very humble growth, and adapted for planting on the faces of rocks, rather than amongst other shrubs, yet they are all deserving of culture.

The genus Cratægus consists of twenty-eight species, and about double that number of varieties, each of which forms a beautiful small tree. There is not perhaps any other genus of hardy ligneous plants in which so many beautiful small trees are to be found. They are all remarkable for having an irregular, picturesque character of outline, and for assuming this character at the growth of even five or six years. They all come into flower at an early age, produce flowers profusely, and all ripen abundance of fruit. The flowers are, for the most part, white and fragrant, but in some varieties they are tinged with red and purple; and in one, the scarlet hawthorn, C. oxyacantha rosea, they are of a fine rose colour. The flowers appear at various periods from March till the middle of July; and one variety, the Glastonbury thorn, often comes into bloom at Christmas. The earliest flowering species are Cratægus purpurea and nigra, and the latest C. cordifolia and Virginica. The colour of the fruit is for the most part red, as in the common hawthorn; but in some it is yellow, as in C. Aronia; black, as in C. nigra; or greenish-yellow, as in C. Mexicana. In C. coccinea the fruit is large, and of a scarlet colour. In C. Douglasii it is of rich glossy purple-black; and in C. orientalis sanguinea, *Arb. Brit.*, it is of an intensely deep port-wine colour. Of the common hawthorn of our hedges, C. oxyacantha, *L.*, there are no fewer than thirty recognised varieties, each of which would form a very beautiful and distinct tree. One of the varieties has the fruit white, another has double white flowers, another, C. oxyacantha phœnicea flore pleno, double red, another a fine single pink. One has black fruit, another yellow, and a third white. In one the entire tree takes the upright narrow form of a cypress, and in another the branches are pendulous, like those of the weeping willow; one has leaves like those of the oak, another leaves like those of the fern, and so on. All the species of Cratægus may be readily propagated by grafting them on the common thorn, by which means, when stocks standard high are used, they become trees fit for planting out where they are finally to remain, at the end of the third season. The species may be propagated either by grafting, by seeds, or by cuttings of the roots. Much ornament might be conferred on the country, and especially on the roads which pass through a hedged estate, if the proprietor were to allow some thorns in his hedgerows to grow to the average height of two or three feet above the top of the hedge, and at that height to bud, or graft these with some of the more tree-growing of the ornamental species. Cotoneaster frigida, affinis, acuminata, and nummularia, are Nepaul small trees of very great beauty, both on account of their foliage and their fruit; so much so, that though we have already mentioned them under the head of sub-evergreens, we have here repeated their names. Amelanchier vulgaris, Botryapium, sanguinea, ovalis, and florida, are very beautiful low trees, which bear a profusion of white flowers early in spring, and are succeeded by brown or black berries, which, though commonly left to the birds, are not disagreeable to eat. The common medlar, and Smith's medlar, Mespilus Smithii, *Dec.*, M. grandiflora, *Hort.*, are ornamental trees: the former is valued also for its fruit, and the latter for the profusion of white blossoms with which it is covered in April. There are a great many very ornamental species and varieties of the genus Pyrus, which is now so far extended as to include species formerly considered as belonging to Sorbus, Cratægus, Mespilus, &c. P. nivalis, sinaica, salicifolia, elæagnifolia, and amygdaliformis, may be considered as white woolly-leaved varieties of the common wild pear, and P. sinensis as a distinct variety of the common cultivated pear. P Bollwylliana appears to be a hybrid between the apple or crab, and Pyrus Aria. P. variolosa, a native of Nepaul, is a remarkable tree, with leaves sometimes like those of the common cultivated pear, and at other times cut, like those of Pyrus spuria sambucifolia. Pyrus prunifolia, baccata, and Astracanica, are crab-apples with handsome blossoms and small beautiful fruit; and there are a number of sub-varieties, which may be obtained in the nurseries. Among these, the white astracan or transparent crab of Moscow, the supreme crab, and Biggs's everlasting crab, deserve the preference. P. coronaria, and P. angustifolia, are American wild apples, with sweet-scented flowers. P. spectabilis, a native of China, but quite hardy, is remarkable for its showy pink and white blossoms, which are produced in great profusion. P. Aria, the white-beam tree, and all its varieties, deserve culture, as compact, low, or small trees; P. vestita, a native of Nepaul, is remarkable for its large woolly foliage, which dies off of a fine yellow. P. torminalis, though indigenous, is a most ornamental tree. Pyrus Sorbus, and all its different varieties, are very ornamental. Pyrus spuria, a native of Kamtschatka, forms a very beautiful little tree, with a profusion of white flowers and black fruit; and Pyrus arbutifolia, Mespilus arbutifolia, *L.* with its varieties, melanocarpa, floribunda, and depressa, are beautiful low shrubs, and, when grafted standard high on the common thorn, form very ornamental objects, whether in blossom, when covered with their fine dark fruit, or when their leaves are dying off, and have become of an intensely dark red, shaded with yellow and purple.

The common and Chinese quinces form handsome low trees; the former more particularly so when in flower and fruit, and the latter when in full leaf. The Japan quince, Cydonia Japonica (Pyrus Japonica, *L.*), is well known as one of the most ornamental spring-flowering shrubs in cultivation. Hamamelis Virginica, the Wych hazel, is valuable from its beginning to flower in November, and retaining its blossoms till February or March: though rarely seen in collections, it is very hardy, and forms a very handsome small tree. The different species of dogwood are ornamental, and, with the exception of C. florida, quite hardy. C. alba sibirica has the shoots of a fine scarlet colour, and is singularly ornamental in the winter season. The common elder, Sambucus nigra, will thrive, and form a handsome low tree, in a variety of situations, where many other trees and shrubs will scarcely grow: on a mountain side, and in the coal-smoke of cities or factories. There is a very handsome variety with cut leaves, one with white fruit, and another with green fruit. S. racemosa is a native of Spain, which grows vigorously in this country. The leaves are finely cut; and the fruit, with which it is generally profusely covered, is of the most brilliant scarlet: being very little known among gardeners, it is scarcely ever seen in collections. The different species of Viburnum are hardy, and all more or less ornamental, both when in flower and in fruit. The leaves also die off of a fine yellow-red, sometimes tinged with purple. V. Lentago, pyrifolium, prunifolium, and nudum, when trained to a single stem, form compact-growing, neat, little trees. The common wayfaring tree, V. Lantana, and the American wayfaring tree, V. lantanöides, form very neat bushes. V. Opulus is well known as the Guelder rose; and the American variety, V. O. oxycoccos, has fruit as large as the cranberry, which is used in America for the same purpose; as is the fruit of V. O. edule, another American variety. The fly-honeysuckle, Lonicera xylosteum, and the Alpine upright honeysuckle, Lonicera alpigena, are the only two species which are sufficiently woody and large to be noticed in this selection; the other species belong to flowering shrubs. The snow-drop tree, Halesia tetraptera, is one of the hardiest of North American trees, and, when in flower, one of the most beautiful: it ripens abundance of seeds in this country, by which it is readily propagated; so much so, that in some parts of England it is, like the American bird-cherry, naturalized in the copses. It is rarely to be met with in Scotland, though few trees so well adapted for the climate of that country are so ornamental. The date-plum, Diospyros Lotus, though it ripens fruit as a standard in the climate of London, is perhaps rather tender for the northern counties; but where the climate is moderate, it forms a very beautiful small tree. The Virginian snow-flower, or fringe-tree, Chionanthus Virginica, is nearly as hardy as the snow-drop tree; and when planted in a moist soil, and trained to a single stem, its head is ornamental from its large, deep-green foliage, independently of the fine, white, fringe-like flowers which are suspended from the axils of the leaves. The common purple and the common white lilacs, Syringa vulgaris, and S. vulgaris alba, are very hardy, and make very neat small trees when trained to a single stem. The common ash is the parent of several varieties which are very ornamental. One of the oldest of these is the simple-leaved ash, of which there is a variety lately discovered in Ireland, with the leaves variegated. The pendulous-branched or weeping ash is a well-known variety, as are the yellow barked and the striped barked. There are several other varieties not in our opinion worth cultivating, though from these we except F. excelsior parvifolia, F. e. p. argentia, and F. e. p. oxycarpa. The lentiscus-leaved ash, F. Lentiscifolia, is an elegant tree; and there is a pendulous variety of it, which forms by far the most graceful tree of the genus. There are several species or varieties of American ash, very ornamental in their foliage, most of them hardy in the climate of London, but few of them adapted for the northern counties. The flowering ash, Ornus Europæa, is a very handsome tree, nearly as hardy as the common ash, and it ought on no account to be omitted in ornamental plantations. Few trees have a finer effect when standing singly on a lawn. Catalpa syringæfolia is a splendid tree when in flower: it attains the height of thirty or forty feet, and sometimes ripens its seeds in the climate of London; but in the northern counties it seldom does much good. It is one of those trees which will bear an immense deal of cold in winter, provided there has been heat and bright sunshine enough in summer to ripen its wood. The tupelo tree, Nyssa, is nearly as hardy as the Diospyros Lotus, and is more beautiful than that tree in autumn, when its leaves change to an intensely deep rich scarlet. The Oleaster or wild olive, and the Hudson's Bay olive, Elæagnus hortensis and argentea, are handsome silvery-leaved low trees; the former, however, rather tender, and the latter rather shrubby. The sea-buckthorn is a very handsome and a very hardy willow-leaved little tree, which has the great advantage of standing the sea-breeze without injury. Hippophæ salicifolia, a native of the mountains of Nepaul, is of more vigorous growth than the European sea-buckthorns, and appears to be nearly as hardy as they are. Shepherdia argentea, the Missouri silver-tree, is an elegant silvery-leaved tree, a native of North America, where it produces an edible fruit: it forms a suitable companion to Hippophæ and Elæagnus, which are also more or less silvery in their foliage. The black, the white, the red, and the tartarian mulberries, are all ornamental trees, but rather tender in the northern counties. The paper mulberry, Broussonetia papyrifera, is an interesting object, but more tender than the common mulberry. Maclura aurantiaca, the American bow-wood, or Osage orange, is a tree of very vigorous growth in the climate of London; but as it continues growing till late in the season, its wood is often not ripened so far as the points of the shoots, and the tree is therefore probably unfit for those parts of the island where the atmosphere is almost constantly charged with fog. The elm comprises many ornamental species and varieties. Of the English or narrow-leaved elm, those which we prefer are U. campestris viminalis, U. c. foliis variegatis, and U. c. virens. U. c. planifolia, and U. c. chinensis, are very beautiful as elms, but difficult to procure. Ulmus effusa is, in our opinion, by far the handsomest species of the European elms when it is in a young state; but it does not grow up to a handsome tree. The most beautiful variety of Scotch elm is the weeping elm, Ulmus montana pendula, which is remarkable for the vigour of its growth, and the picturesque manner in which its branches are thrown about. There are some American elms which are tolerably hardy in the climate of London, but which cannot be recommended for colder districts. Planera Richardi is an Asiatic tree, and attains the first rank even in the climate of London, where it sometimes ripens seeds; it deserves a place along with the elms, and along with the southern and eastern nettle-trees, Celtis australis and Tournefortii. The common walnut-tree, Juglans regia, though it becomes a tree of the first rank in the climate of London, and is cultivated for its fruit both there and in Devonshire, yet in the north has generally the points of its young shoots blackened by the spring frosts. Of the willow there are a great many species and varieties, all of which are highly ornamental when in flower. Of these we may recommend the almond-leaved willow, S. amygdalina; the sweet-scented bay-leaved willow, S. pentandra; the weeping willow, S. Babylonica; the golden willow, S. vitellina; and the purple-barked willow, S. atropurpurea. The poplar genus contains several ornamental species. The first we shall mention is Populus tremula grandidentata, *Arb. Brit.*, the North American large aspen, of which there is a pendulous branched variety. P. heterophylla is an American poplar, little known and rarely met with in British nurseries. The balsam poplar, P. balsamifera, is one of the earliest trees, which sends out its leaves in spring; and it and the Lonicera Tatarica, in the climate of London, are found clothed with leaves a week or a fortnight sooner than any other tree or shrub whatever. The leaves of the balsam poplar, when they first come out, are of a rich yellow, and they perfume the air with their fragrance for some distance around; as the summer advances, they become darker, till in the autumn they are of a black or bluish green. It may give some idea of the extreme hardiness of this tree to mention, that Captain Franklin found it as far north as the Great Slave Lake; and that the greatest part of the drift-timber which he observed on the shores of the Arctic Sea was of this species. It is one of those poplars that send up suckers, and it is consequently readily propagated by cuttings of the roots. It prefers a moist soil, and though the Cree name for this species means ugly poplar, yet when full grown on such a soil, it forms a very massive round-headed tree, which at a distance might be mistaken for an oak or a chestnut, as is proved by two fine specimens in the grounds at Syon. The Ontario poplar, P. candicans, bears a close general resemblance to the balsam poplar; it has the rigid fastigiate habit of that tree, the same habit of sending out its foliage before all other poplars, its fine fragrance, and its property of throwing up suckers from the roots; but it differs from the balsam poplar in having very large heart-shaped leaves. It is rather more difficult to propagate than the balsam poplar, and, in British nurseries, is commonly raised from layers. The genus Alnus, the alder, contains some very ornamental trees. A. glutinosa laciniata has finely-cut foliage, and, what is remarkable, is in general a more free-growing tree than the species. A. cordifolia is a native of Calabria, and by far the handsomest species of the genus. We have already mentioned it as probably fit to be grown for its timber. A. incana, the hoary-leaved alder, is a very handsome tree, and has the advantage of preferring dry soil. A. oblongata, serrulata, undulata, and viridis, are low trees or large shrubs, quite hardy, and deserving of introduction into collections. The birch is a genus of which the greater number of species are natives of North America; and, though they are valuable timber-trees there, none of them in this country have yet proved anything more than ornamental. The finest American species is B. nigra, distinguished by the beautiful paper-white of its bark, which cracks, separates into thin laminæ, and rolls up, even when the tree is young and only two or three inches in diameter. B. populifolia is a handsome species, very much resembling the common birch, and in our opinion only a variety of it, as are B. pubescens, urticifolia, pontica, Darlecarlica, and others. There is a cut-leaved, pendulous variety of the common birch, which is very ornamental. The paper-birch, B. papyracea, is a fine tree; as are B. glandulosa and B. Däurica. B. fruticosa, pumila, and nana, are shrubs.

Of oaks there are upwards of forty species introduced into British gardens; the greater number of them, with many varieties, being purchasable in British nurseries. All these, with the exception of the two varieties of the common oak and the Turkey oak, may be considered as solely or principally ornamental. Of the common oak, Q. pedunculata, there are three varieties, very distinctly marked, viz. the cypress oak, Q. p. fastigiata; the weeping oak, Q. p. pendula; and the cut-leaved oak, Q. p. heterophylla. These three varieties often ripen acorns, and of the plants raised from them a number are found to have the same habit as the parent. There are several varieties of Q. sessiliflora, which differ in the size of the acorns, in the size of the leaves, in the greater or lesser degree in which these are cut, and in the presence or absence of pubescence; none of these varieties, however, have yet been propagated by the nurseryman, excepting Q. s. pubescens. The Pyrenæan oak, Q. Pyrenaica, is a very handsome and distinct species, of low growth. Q. Apennina is also a low tree. Q. Esculus, the Italian oak, is a tree under the middle size, which thrives well, and ripens its acorns in the climate of London: there are fine specimens at Whitton Park. Of the Turkey oak, Quercus Cerris, there are ten or twelve very distinct varieties. The first of these is the pendulous variety, the next the Austrian, then the Ragnal, the Fulham, and the Lucombe. Of the latter there are five very distinct sub-varieties, all sub-evergreen, and all well deserving of culture wherever the common Turkey oak will thrive. Quercus Ægilops, the Velonia oak, thrives in the climate of London; but is probably too tender for the northern counties. The American oaks, which are deciduous, may be classed as the white, red, black, and willow oaks. The white oak best worth cultivating in Britain as an ornamental tree is Q. alba; but Q. olivæformis and macrocarpa are remarkable for their fruit, and Q. obtusifolia and lyrata for their leaves. The chestnut oak, Q. Prinus, and its several varieties, also deserve culture: the leaves of these oaks resemble those of the sweet chestnut, and the species is to the other deciduous American oaks what Q. sessiliflora is to the deciduous oaks of Europe. Q. alba bears the closest resemblance to Q. pedunculata, and may be considered as being the American form of that species. All the red oaks are beautiful in the form and colour of their foliage; and some of them attain the size of timber-trees in Britain, though their wood is of little value either here or in America. Q. rubra, and coccinea, and tinctoria (the Quercitron), are perhaps the most ornamental; and Q. palustris is the hardiest, the most rapid growing, and the handsomest in point of general form. The black American oaks are all remarkable trees. The black-jack oak, Q. nigra, *L.*, is the most extraordinary species, from the very singular form of its leaves; and next to it is Q. aquatica. Q. illicifolia, heterophylla, and agrifolia, belong to this division. The willow oaks, Q. Phellos, imbricata, and laurifolia, have entire leaves, which die off without changing colour; and this group may be considered the least ornamental of the American oaks.

The American hornbeam, Carpinus Americana, and the common and Virginian hop hornbeams, Ostyra vulgaris and Virginica, deserve a place in collections, more especially the hop hornbeams, from the singular appearance of their fruit. Of the common hazel there are some ornamental varieties, such as that with purple leaves, and another with cut leaves. The Constantinople hazel, Corylus Colurna, forms a very handsome middle-sized tree; and C. rostrata and Americana are hardy, and well deserving a place in ornamental plantations. The oriental and occidental planes are highly ornamental trees of the first rank, and Platanus Orientalis acerifolia, *Arb. Brit.*, and P. O. cuneata, *Arb. Brit.*, are fine varieties, the latter forming a curiously-twisted low tree. The Liquidambar is a splendid tree, remarkable for the beauty of its foliage and its refreshing fragrance. Liquidambar imberbe is a small tree, also very ornamental. The Ginkgo or maidenhair tree, Salisburia adiantifolia, *Sm.*, is remarkable for the singularity of its foliage: it is a native of China, but is quite hardy in most parts of Britain; and it is propagated without difficulty by cuttings made in autumn. Of the larch there are some species and several varieties, which are chiefly ornamental; those best deserving of culture are L. Europæa pendula, L. Americana pendula, and L. Americana rubra. The deciduous cypress is rather tender in the northern parts of the island; but in the climate of London, when planted where its roots are within reach of water, it forms a magnificent tree of the first rank.

III.—*The Nursery Culture of Trees.*

We have now gone through the whole of the hardy trees and shrubs of Britain, and have indicated those which we think best deserving of culture, where the objects are either timber-produce or general effect, and where no extraordinary care is proposed to be bestowed on the soil. The reader cannot fail to be surprised at the very small number of species which merit to be planted for the sake of their timber, and at the great number which we have enumerated as ornamental. That number would have been more than doubled had we included the flowering shrubs, and such foreign trees and shrubs as will only thrive in the southern parts of the island; but we have confined ourselves as much as possible to those which will thrive both in the climate of London and in that of Edinburgh. It must be recollected that all the ornamental trees produce timber of some sort; and some of them, such as the box, crab, common maple, &c., timber of considerable value. Every ornamental tree, therefore, may be considered a useful tree, even with respect to the wood which it produces; though, from the length of time it takes to produce that wood, it may not be a profitable tree to cultivate for that purpose. Having treated on the trees worth cultivating, we shall now enter on the subject of their cultivation.

The cultivation of trees and shrubs includes their propagation and rearing in the nursery, and their culture and management in plantations.

Nursery Culture.—A nursery is any plot of ground devoted to the propagation and rearing of trees and shrubs. To be perfect, it ought to contain the principal kinds of soil in which trees and shrubs grow, and to possess different climates, according to the countries of which the plants are natives; but as these requisites cannot be always obtained, particularly with respect to climate, all that art can do is to make the nearest approach to them that circumstances will admit. It may be laid down as a general principle, that all seeds will germinate, and all plants grow, in any kind of soil whatever, provided it contain some vegetable matter, be in a state of minute division, and be retentive, to a certain extent, of water. All plants, therefore, may be reared in a nursery containing only one kind of soil; but in such a nursery all will not be equally well reared; for some plants, such as all those which have hair-like roots (as the ericaceæ, including the heaths, rhododendrons, arbutuses, &c.), and in general all that are called peat-earth plants, will only thrive in a peaty-soil; or a soil composed of a mixture of very fine sand, and thoroughly decomposed leaves, or woody matter. Other plants, such as all those which attain a large size, and have strong tap-roots, will only thrive in deep loams or in deep fertile sands, though they will grow for a time very well in peat. A nursery, therefore, that contains the three leading soils of sand, loam, and peat, will suffice for all the purposes for which the most extensive nursery can be required; and, for raising such trees and shrubs as have been treated of in this article, a piece of ground containing sandy loam in one place, and clayey loam in another, or even sandy loam throughout, will be quite sufficient, as far as regards soil. With respect to climate, all the deficiencies which can occur in Britain may be made up by glazed frames, in which the more tender kinds can be raised; and in which those which are grown in pots can be kept through the winter. A nursery may be considered in two points of view: with reference to the nurserymen, and with reference to the climate and soil where the trees are finally to be planted. As matters stand at present, it is the interest of the nurseryman to have his nursery in a fine climate, and in deep, fertile soil, in order that he may raise large vigorous plants in the shortest possible period: but it is the interest of the purchaser to have the plants reared in a climate and soil inferior to that into which they are to be transplanted; because, when this is done, instead of the plants receiving a check from the operation of transplanting, as is usually the case, they will be improved by it. It is the interest of the nurseryman to have his nursery trenched and manured to the depth of two or three feet; in order that it may contain abundance of nourishment, and be retentive of moisture during the summer season, so as to cause the plants to produce long and vigorous shoots. On the other hand, it is the interest of the purchaser that the soil should not be cultivated to more than eight or ten inches in depth, in order that the nourishment and the moisture, and consequently the roots, may be concentrated in a very limited space; so that, when the plants are taken up, the whole of the roots may be taken up with them, which, where the ground has been trenched, is impossible, from the great depth to which they will have penetrated. It is for the interest of the nurseryman that the summer should be moist, in order that the shoots produced may be long and strong; but it is for the interest of the purchaser that the summer should be dry, in order that the shoots may be short, and thoroughly ripened; and that the roots should cease to grow early in the autumn, in order that their spongioles, having had time to harden, which they cannot do till they have ceased elongating, may receive the less injury when the plants are taken up. In short, it is the interest of the purchaser to concentrate all the forces of the plant within such limits as he can thoroughly command, that is, can take up and carry away. The advantages of then sowing and planting to the planter, therefore, are obvious, though the reverse is for the interest of the nurseryman; as by thick planting the plants are drawn up taller and straighter, and a greater number will grow on a given surface. We are fully aware of the arguments which are opposed to this doctrine by nurserymen; viz. that the stronger a plant is, and the greater the number of its fibrous roots, the more likely will it be to succeed after being transplanted to a new situation; and that this strength of shoot, and abundance of fibrous roots, can only be produced in deep, rich soil. But we deny that this vigorous appearance in the shoots of plants is strength; and assert that, so far from a deep soil being favourable to the production of fibrous roots, it is directly the reverse. The strength of a plant, and its suitableness for being removed from one situation to another, and for growing vigorously after it is removed, consists in all its parts having arrived at maturity, in the thorough ripening of its wood, and in the completely dormant state of its fibrous roots; and these requisites, we assert, can only be obtained by concentrating the nourishment contained in the soil into a limited space, by the soil being compact, and by no more moisture being admitted to the roots than what is absolutely necessary to complete the growth of the season in sufficient time to allow of the thorough ripening of the young wood. If by any mode of culture these requisites can be obtained, together with the long and thick shoots which are produced by growing the plants in deep, rich soil, so much the better; but we contend, that, in the climate of Britain, this is impossible. If the purchasers of plants in nurseries will observe what takes place in the case of layers, as in those of the elm, the lime, the platanus, the white poplar, the vine, &c. they will see the justice of our statement. Such layers made in spring have generally at the end of the season shoots of three or more feet in length, which have continued growing till they were checked by frost; the consequence of which is, that neither the wood nor the fibrous shoots have ripened. The first year after removal, such plants make scarcely any growth; and if they survive the first year, it requires two or three years more before they are firmly established. Nearly the same thing may be said of almost all one-year grafted or budded fruit-trees, which, having seldom ripened their wood thoroughly, from being planted in deeply trenched rich soil, and half of their roots having been left in the ground after they are taken up, are consequently obliged to be cut in when planted. These considerations show, as a general principle, the advantage of growing all plants that are to be transplanted, in such a manner as that they may thoroughly ripen their wood and roots, and so that the whole of the roots may be taken up with the plant. On a large scale, the only mode of effecting this is by having the soil shallow and rich, but not too moist. On a small scale, the same end is attained in a very complete manner by growing the plants in pots; and, were it not for the expense, this would be the best mode of growing all nursery articles. The plants, however, should not be kept too long in pots, because, when so treated, many species, after a time, acquire a stunted habit, and the roots, when the tree is transplanted, instead of being in a state to allow of their being unwound from the ball, and stretched out in lines radiating in every direction from the stool, are so long and slender, and the circulation through them is so languid, that they require to be cut off or shortened. In general, it may be observed, that a weak plant, with the wood and roots thoroughly ripened, is much more likely to thrive when transplanted, than a strong one from which a great part of the roots have been cut off; and hence, of two young Huntingdon elms, budded on the Scotch elm, one of which had been grown in a pot, and had its leading shoot only two feet long, and another which had been grown in the free soil, and had its leading shoot five or six feet long, as is often the case—the former, when transplanted where it was finally to remain, would far sooner attain the height of twenty or thirty feet than the latter. We do not expect that all commercial nurserymen will subscribe to these opinions, but private gentlemen who raise their own trees will find it their interest to attend to them. Hence those who plant in mountainous districts will always find it better to have their nurseries on the sides of the mountains than in the valleys.

Propagation.—Trees, like other plants, are chiefly propagated by seeds; but they are also increased by cuttings, layers, budding, and grafting. The timber-trees of all countries are raised from seeds, with the exception of a very few, such as the poplar and the willow, which are raised from cuttings; and some species of elms, limes, and a few others, which are raised from layers, or by grafting. The greater number of ornamental trees and shrubs are raised by some of these artificial methods; because in this country they seldom ripen seeds, and because varieties are always perpetuated by artificial modes. Thus, all the American oaks are, or may be, grafted on the common British oak. Most of the foreign acers and birches are raised by layers, most of the ornamental thorns by budding and grafting, and almost all the ornamental willows and poplars by cuttings. All plants which do not ripen seeds readily are propagated by some of these artificial modes; and that mode is preferred by the nurseryman, which, experience has proved, will produce the largest and most vigorous-looking plants in the shortest time. Thus, though more suitable plants for the planter would be produced by raising the platanus and the white poplar from cuttings, because in that case nature would adjust the tops to the power of the roots; yet, as much larger plants are produced by layers, that mode is everywhere preferred in the commercial nurseries. The lime-tree ripens its seeds in this country, and also the English elm; but large plants are much more rapidly procured in the first case by layers, and in the second by grafting. We do not say that in every case the mode by which the largest plants are most rapidly produced should give way to the slower mode; but merely that, in most cases, it would be advantageous to the purchaser that the slower mode should be adopted. According to some writers, plants which are raised from cuttings, or by any other mode than by seeds, are of less durability than seminal plants; but though this may be true, or appear so, in a few instances, it can never be adopted as a general principle; since, from all that we are taught by physiology, a bud contains as perfect an embryo of a plant as a seed: the only difference being, that the bud is more powerfully imbued with the peculiarities of the individual which produced it than the seed is. This doctrine is confirmed by experience; since the poplar, the willow, the vine, &c., have been propagated by cuttings from time immemorial, and, for any thing that is known to the contrary, possess respectively the same properties now that they did in the days of the Romans.

Propagating by Seeds.—The seeds should be collected from the handsomest individuals of the species, when they are quite mature; and they should either be sown immediately, or preserved in a place where they will undergo few changes in regard to heat or moisture, till the proper sowing season, which, in almost every case, will be the following spring. Nature, it may be observed, sows all her seeds soon after they are fully matured; that is, they drop from the tree upon the ground in autumn, or the beginning of winter, or, in the case of some trees, such as the pines and firs, not till the following spring; but as, when seeds are thus left to chance, the greater part of them are destroyed by vermin, by being placed in a condition not favourable for germination, or by imperfect or premature germination, only a moderate number of them produce plants. It is the business of art, therefore, to study what is favourable and unfavourable in nature's mode of sowing seeds, and to imitate only the former. The result of this study is, that by far the greater number of seeds may be kept with advantage from the time they ripen, till early in the following spring, that is, till February or March, and then be committed to the soil. There are a few exceptions, as in the case of poplar and willow seeds, which ripen early, and which, when sown immediately that they drop from the tree, often come up in the course of a few weeks; whereas, if they are kept till the following spring, the greater number do not come up at all; and also in the case of seeds which lie two years in the ground before coming up, such as those of the hawthorn, the holly, &c. and which may be kept till the second spring after being ripened before they are sown. In order to show the treatment required for the seeds of different kinds of trees, and the plants raised from them in the nurseries, it will be convenient to throw them into groups; and these may be as follow: the pine and fir tribe; the trees producing nuts, acorns, masts, and keys; trees producing pomes with kernels, berries with stones, berries in capsules, small seeds, leguminous seeds, and cottony or papery seeds.

The seeds of the pine and fir tribe ripen from October till January, and if the cones are allowed to remain on the tree throughout the winter, the seeds do not in general drop out till the following April or May; soon after which, such of them as drop into a favourable soil, where there is a certain degree of moisture and shade, come up in five or six weeks. The nurseryman collects the cones of each species immediately after they are ripe (which, with the pinaster, and a few others, is as early as the month of October), and he lays them by in a dry place till he has leisure to extract the seeds. This he does by exposing the cones to the heat of the sun under a glass case, by which the heat is retained, and raised to a higher degree than it would be in the open air; or he subjects them to artificial heat before an open fire, or on a kiln. The seeds, when taken out, are sown in April, in soil dug over, and rendered fine by raking; and over them is laid a covering of soil, which, in general, need not be deeper than the thickness of the seed to be covered, where the soil is loamy;

but it may be twice that thickness where the soil is a coarse sand. In order to retain a uniform degree of moisture on the surface, the beds, after the sowing is completed, should be shaded from the sun, by covering them slightly with the branches of trees, and especially with those of evergreens, such as the spruce fir. In cold moist climates, such as that of Aberdeen, this shading may be dispensed with; but in the climate of London it is, in most seasons, essentially necessary, and may be effected by hoops and mats, by fronds of fern, by straw, or by pea haulm. For greater convenience, the seeds are generally sown in beds, a slight excavation being made in the beds by drawing some of the earth to the sides; and in order that the seeds may be evenly deposited on a somewhat firm surface, the bottom of this excavation is rolled with a light roller. After the seeds are distributed over the beds, at such distances as that the plants, after they have come up, and have grown to the end of the season, may not touch each other, the beds are again rolled, and afterwards the covering of earth is thrown over them which was drawn off before rolling and sowing. It may be observed here, that the rolling in of the seeds, by bringing them in close contact with comparatively firm soil, renders a much thinner covering of earth necessary than if the seeds had been sown on a loose surface. It is also more favourable to the vegetation of the seeds; it being found that close contact with the soil, both in the case of seeds, and the spongioles of the roots, is a powerful stimulus to vegetation. Some of the more tender species of pines and firs, such as the stone pine, the cedar of Lebanon, the cypress, &c. are commonly sown in pots, or in flat earthen pans, for the convenience of making them germinate under glass, and in order to facilitate future transplantation; but the process of preparation, sowing, and covering, is exactly the same as when the seeds are raised in beds. The plants, after they have come up, require nothing but the usual routine culture of the nursery for two summers; at the end of which period they should be taken up, and, if possible, transplanted where they are finally to remain; but as this cannot always be done, the next best practice is to plant them in the nursery, either in lines, which is the most convenient mode, or scattered over beds; in either case keeping the plants so far apart that there may be a clear space round each plant, of from three to six inches, according to its height and the length of its leaves. Thus, for the Scotch pine and the spruce fir, which grow slowly when young, and have comparatively short leaves, three inches will be sufficient; whilst for the larch, which grows rapidly the second year, and for the pinaster, which has long leaves, six inches will be required. Here the plants may remain another two years, and afterwards be transplanted on the same principle; unless they are in the mean time removed to where they are finally to remain. Unless this has been the case, they will have little chance of doing good as timber-trees; for experience has proved, that after two years' growth, or at most four years', all the pine and fir timber are materially checked by transplanting; and that this check is of a kind which cannot, like that given to broad-leaved trees, in a similar case, be counteracted by cutting them down to the ground; but, on the contrary, remains for many years, and materially affects the future growth and habit of the tree.

Trees bearing Nuts, Acorns, Masts, Keys, &c.—These, on British timber-trees, ripen from October to December. The greater part of oaks ripen their acorns in November; but the beech, the horse-chestnut, the walnut, and the hazel, ripen their mast and nuts in October; and most of the sycamores and maples their keys in September. All these seeds ought to be gathered as soon as they are ripe; because, as they form an important part of the food of wild animals, the best are liable to be picked up by them as soon as they drop. They may either be sown immediately or kept till February, as in neither case will they come up till April or May. They should be sown in a sandy loam, in drills, the seeds being deposited at such a distance from each other, that the leaves of the plants springing from them may not touch at the end of the first season; they should be trodden into the drill with the foot, or pressed down with the back of a wooden rake; and they may be covered to the depth of twice or thrice the thickness of the seed. The reason why drills are recommended for this description of tree-seeds is, that in the intervals between the rows, a spade may be inserted obliquely, so as to cut through the tap-roots of the plant, and force it to throw out lateral roots. This operation is commonly performed early in the spring of the second year: it does not prevent a second tap-root being formed from the mutilated extremity of the first; but it throws a greater proportion of the energies of the plant into the lateral roots, which, by increasing these and their fibres, renders the tree better adapted for transplanting. At the end of the second year, plants so treated may be taken up, and either planted where they are finally to remain; or, their tap-roots being shortened, they may be transplanted into nursery lines, at distances adjusted according to the principles laid down for transplanting the pine and fir tribe. In this situation they may remain two years longer, and then be taken up and again replanted in the nursery; because all broad-leaved tap-rooted trees differ from needle-leaved trees in this important particular, that the larger and stronger they are, up to a certain point, before they are removed from the nursery, and planted where they are finally to remain, the more vigorously will they grow there. The point or limit to the size which they may be allowed to attain in the nursery must be regulated by the condition of the soil into which they are to be transplanted, relatively to moisture. If this be abundant, so as to supply all the fibrils with water during the first summer, even if the removed plant has a stem an inch in diameter, so much the better; it being clearly understood that it has been transplanted in the nursery every two years, and is consequently abundantly supplied with fibrous roots, and has all its wood perfectly ripe. If, on the other hand, the soil into which the plant is to be transplanted is naturally dry, and perhaps also thin and poor, the plants should be removed from the nursery thither at the end of the second year. The reason is sufficiently obvious; such plants, being of small size, have few leaves to exhale moisture, and before they grow large they will have adjusted their roots and annual growths to the locality.

Trees producing Pomes with Kernels.—This class includes the genera Pyrus, Cydonia, Amelanchier, Cotoneaster, Viburnum, &c. The fruits of the different species of these genera ripen at various periods from September to November. They should be gathered when ripe, and each kind should be mixed with sand, and laid up in a heap, in order to rot away the pulp. This heap may be turned over several times in the course of the winter; and in the month of February it may be sifted, and the seeds separated from it, and sown in beds, exactly in the same manner as is done with the seeds of the pine and fir tribe. After the plants have been two years in the seed-bed, they may be transplanted into nursery lines, on the same general principles as already described.

Berries having Stones.—This class includes the genera Cratægus, Ilex, Taxus, Prunus, Cerasus, Rhamnus, and some others. The fruit ripens from August (as is the case with some species of Cratægus) to December. It should be gathered as soon as it is thoroughly ripe; and after having been mixed with sand or sandy soil, the mixture should be laid up in moderate-sized heaps, exposed to the weather, and turned over frequently for two years, after which it may be taken, along with the sand, and sown in beds; and when the plants come up, and have grown two years, they may be transplanted, and treated like the others. In general, all the plants belonging to this class, whichever way the seeds may be treated, whether they are sown immediately that they are ripe, or kept in a rot-heap two summers, will not come up till the spring of the third year; but there are some positive and some accidental exceptions. Amongst the former are the yew, the berries of which generally come up at the end of the first year, and the wild cherry, which, if sown in July, immediately after the fruit is ripe, will come up the following spring; whereas, if kept till August before it is sown, it will not come up for two years. As casual exceptions, we may mention that the holly and hawthorn, when the berries are macerated in water as soon as they are gathered, and sown immediately afterwards, will, in some seasons, come up the following spring in considerable numbers; though the same treatment in other seasons, in the same nursery, will not be attended with the same results.

Berries and Capsules having small Seeds.—This class includes the elders, the privet, the spindle-tree, the barberries, and some others. The fruit may be treated like the pomes; and great care should be taken, after it is rotten, either that the seeds are completely separated from the sand before they are sown, or that the sand and seed, when sown together, should be so distributed over the bed as that the plants may come up at regular distances, and sufficiently far apart. The covering of soil should be very thin, more especially if the seeds are rolled in; and the beds should be shaded by branches or matting till the plants are fairly above ground. At the end of the second season they may be transplanted into nursery lines as before.

Leguminous Seeds.—These include the genera Cytisus, Robinia, Gleditschia, Caragana, &c. The pods generally ripen in September or October; but some of them, such as the Gleditschia, not till November or December. The seeds may be kept in the pods till February, and then taken out and sown in beds, on the principles before laid down. At the end of two years the young trees may be transplanted as before.

Cottony, Papery, Feathery, and other soft Seeds.—These include the genera Populus, Salix, Alnus, Betula, Ulmus, &c. The seeds ripen from May to November; all the poplars ripen their seeds in May; all the willows and elms in June; the alders in November; and the birches in October. The seed of the alder and the birch may be kept in a cool, dry, airy situation till the following spring, or it may be sown immediately after it is gathered. In either case it comes up in the May or June following; but it is preferable that the seeds of the elm. the poplar, and the willow, should be sown immediately, because in that case they are much more certain of coming up. Many of these seeds will come up the same autumn, and the remainder the following April and May. The seeds may be dried and preserved in bags for a year; but in this case the greater part of those of the poplars and willows will not vegetate. The reason may be, that the seeds, when preserved, are kept too warm; which must necessarily deprive them of their moisture, through the absorption of the cottony substance with which they are enveloped. Poplar and willow seeds require to be sown on a surface rendered quite even, and slightly firm, by rolling. Afterwards the seeds should be evenly distributed over it, and they should be covered with very light, sandy soil, or peat or vegetable mould, if either can be procured, no thicker than barely to conceal the seed from the eye. After this the beds should be watered, and effectually shaded, by being hooped over and matted; and they should be kept in a uniform state of moisture, by occasional supplies of water, when the plants make their appearance. Of all the seedling trees raised in British nurseries, none come up and grow with so much vigour, the first year, as the common broad-leaved elm; and, therefore, the seeds of this tree require to be placed at a greater distance from each other in the seed-bed than those of any other kind. The seeds of the elm also keep much better till the following spring than those of the poplar and willow, and they are generally so kept by Scotch nurserymen.

IV.—*The Culture of Trees in the Plantations. The Formation and Management of Plantations.*

Whether plantations of forest-trees should be sown or planted, is a question which has been agitated and discussed by different writers. It is readily allowed, that sowing is the natural mode; but it is the business of art to improve upon nature, and to attain the same ends which she does, by more definite means. If this general principle be correct, it affords at once a decisive answer as to the respective eligibility of sowing or planting; unless, indeed, it can be shown, which some have attempted to do, that the timber of transplanted trees is never so valuable as that of sown ones. The only reason alleged for this is, that the transplanted trees have lost their tap-roots; and although a more frivolous one could hardly be imagined, yet it has been maintained by a number of writers, and is still insisted on by a few. On examining the roots of full-grown trees, however, either in natural forests or artificial plantations, no tap-root is ever found; on the contrary, those roots which proceed either directly or obliquely downwards from the base of the trunk, are uniformly found much smaller than those which proceed from the base of the trunk horizontally, at a few inches distance under the surface of the ground. The tap-root, therefore, is chiefly of use to the tree whilst in a young state; and if we trace a seedling oak through the first ten years of its progress, we shall find that, in the first year, the tap-root is larger in proportion to the part of the plant above ground, than it is in any succeeding year; and that as the top of the tree and the lateral roots increase in size, the tap-root ceases to increase, till at last, even at so short a period as ten or twelve years' growth, it is found to be the smallest of all the main roots of the tree. We assume it, therefore, as agreed on by the most intelligent planters, that a transplanted tree, other circumstances being the same, is in all respects as good as a seedling one. Hence we conclude, that all artificial plantations ought to be made by planting the trees, and for a similar reason we would plant these in rows at regular distances; and, in short, treat them, as far as is practicable, like a crop of herbaceous vegetables, when reared in the kitchen-garden or in the field. We would prepare the soil, and even manure it for the trees, with as great care as we would for a crop of turnips or cabbages; and we would stir the surface afterwards for two or three years, till it began to be covered with the branches of the trees; in which state we should leave it during the whole period of the growth of the plantation, only taking care to remove large weeds. We admit, however, that this kind of tree culture can only take place with advantage on a tolerably even surface, and where the soil is of the same nature throughout; but we think it right to lay it down as a general principle of guidance, in so far as it can be followed, for planters in all other soils and situations. With the exception of the ground destined for ornamental plantations about country houses, the great majority of cases in which plantations are to be formed with a view to profit must necessarily be on hilly and irregular surfaces; and where there is probably a considerable variety of soil, even in a very limited space. The only preparation that in cases of this kind can be given, is under-draining; for to dig or trench the surface would render it liable to be washed away by heavy rains and thawing snow. Plantations under such circumstances must be formed by digging pits for each particular tree, and by making use of such kinds as are thought to be best adapted to the particular soil and situation. This will frequently occasion the use of a considerable variety of trees in the same plantation; but the effect will be as much more interesting in point of beauty, as the result will be advantageous in point of timber produce. We have already stated, that needle-leaved trees should, if possible, be transplanted when they are not older than two years; but that broad-leaved trees may be transplanted at four, six, eight, or ten years' growth; provided they have been removed every two years in the nursery, and that the soil in which they are placed is sufficiently deep and moist to bring all the fibrous roots into full action the first summer. In the planting of irregular surfaces, which cannot be done by digging, when strong plants of this kind are used they overcome the natural herbage immediately; and, if carefully planted, not one in a score will fail. Smaller plants, on the other hand, are apt to be choked by the grass or herbage, and to have their leaves and young shoots injured by the insects which never fail to abound in such situations. When such surfaces have naturally a very dry soil and subsoil, plants with such a mass of roots as those which we have mentioned cannot subsist on them the first year; and therefore smaller plants, or such as have been only once transplanted, are preferable.

Notwithstanding these arguments in favour of planting instead of sowing as a general practice, there are circumstances under which sowing is either the preferable, or perhaps the only mode, that can be adopted. In every case of making plantations of the pinaster, or of the cedar of Lebanon, unless we could procure a sufficient number of plants of two years old in pots, we should prefer sowing a patch of seeds in every place where a plant was intended finally to remain. Three seeds in a patch would be sufficient; and if more than one came up, the rest should be removed the second or third year. In cases of this kind the plants require to be looked over two or three times every year, to prevent the surrounding herbage from choking them. When steep rocky cliffs, or the sides of hills, consisting of loose naked stones, are to be covered with wood, then sowing is the only mode that can be resorted to. The kind of rock having been ascertained, in order to discover the nature of the debris or soil collected in its clefts, or under the loose stones, the kinds of seeds to be sown may be selected accordingly. Where the soil is good, acorns, ash-keys, maple and sycamore keys, and beech mast, may be introduced; but where it is poor, the safer mode will be to sow seeds of the Scotch pine, the larch, the birch, the mountain ash, the white-beam tree, and the elder. Where there is no visible soil, each seed, or two or three seeds, may be enveloped in a composition of common green moss, cow-dung, and loam, and these balls being deposited in clefts or crevices, or among loose stones, and left to be acted upon by the rain, will swell and burst, and the seeds which they contained will vegetate, and find nourishment in the fragments of the ball in which they were enveloped. When the object is to cover drift sand with wood, the practice followed in the downs or landes of Bordeaux may be adopted, with suitable variations. A zone of the downs, or sandy surface, on that side from which the prevalent winds blow, is first to be sheltered by a fence of boards three or four feet in height. This will protect a zone of twenty or thirty feet in width; that is, it will prevent the drifting sands from covering this space to any great thickness. On this zone the seeds of broom, as being a plant that will grow on the poorest soil, are to be sown; and, among these, the seeds of the tree which is considered the most suitable for the particular situation. Near the sea this will generally be found to be the pinaster; but in the interior of the country, where the sands are not deep, perhaps the birch or the Scotch pine may be found eligible.

Two of the most important points connected with the formation of plantations, are the distance at which the trees ought to be planted from each other, and the introduction or non-introduction among them of nurse-trees. When both these points were first settled by professional planters, the important uses of the leaves of plants were not at all understood by practical men. Hence they gave directions for planting the trees at such distances as that they might draw up one another; without considering the loss of the leaves on the sides of each plant which this drawing up will produce. As the strength of every plant depends on the number of its leaves, and on the full exposure of these to the light, it follows that the strongest young trees will be those which are clothed with branches and leaves from the ground upwards, and which have their leaves fully exposed on every side to the perpendicular light. In regard to the distance from each other at which trees can be planted in a plantation, we should say, begin by planting at a greater or less distance, according to the size of the plants and the nature of the soil and situation; but do not neglect to cut down, or thin out, the moment the lower branches of the plants interfere with one another. Continue this practice year after year, till the lower branches begin to show symptoms of decay at their extremities; when, instead of thinning out the trees, the process of pruning them may be commenced. The lower tier of branches may then be cut off close to the stem, it being understood that such pruning shall take place before the branches are more than an inch in diameter at the point where they join the stem, even if the extremities of the branches have not begun to decay. The trees may then be left to grow, either till another tier of branches begins to show symptoms of decay, when, of course, that tier must be cut off immediately; or till the points of the healthy branches interfere with those of the healthy branches of the surrounding trees, in which case thinning must be resorted to as before. In this way the process of thinning and pruning ought to go hand in hand, till the trees have attained their average height; by which time the different species will be found standing at distances differing according to the height of each tree and the nature of its branches. Thus those trees which will be found standing closest together when full grown, will be the pine and fir tribe; because in them the branches never attain a timber size, and the lower tiers begin to decay at their extremities sooner than in any other trees. On the other hand, the oak has more widely-spreading and durable branches than any of the other broad-leaved trees; and hence, when plantations of this tree are fully grown, the individuals will be found at a greater distance apart than those of any other species of broad-leaved tree whatever. What this distance will be must depend on the soil and situation; because in some localities the common British oak will attain double the height and breadth of head which it does in others. Our business here is to illustrate a principle; and we shall leave it to planters who approve of it, to deduce the rules from it which will apply to their particular cases.

The next point which we have to discuss is the advantage or disadvantage of introducing nurse-plants into plantations. That these have a tendency to accelerate the growth of trees in an upward direction for a number of years after the plantation is made, there can be no doubt; but this is always at the expense of the side-branches and side-leaves, and consequently of the thickness of the trunk of the tree to be nursed. The question, therefore, is, what is gained by the nursing? Is there any advantage in having a young tree with a tall, slender stem, and few or no side-branches, rather than a tree of half the height, with a short, stiff stem, clothed with branches and leaves from the ground upwards? We admit that evergreen nurses, such as the Scotch pine and the spruce fir, considerably improve the climate of a plantation, by preventing the radiation of heat from the ground; and that, provided they did not do injury in other respects, in this respect they would do good. The question as to nurses or no nurses may, we think, be satisfactorily answered in the following manner: Suppose we adopt the principle already laid down, that all trees in plantations intended to produce timber should be kept at such distances by thinning and pruning, as that the extremities of their lowest branches should never interfere. Then, having fixed on the kind of tree the growth of which is to be the main object of the plantation, and the number of these that, when full grown, can stand upon an acre, or any given surface, plant them in their proper places, and fill up the intervals with the trees intended to serve as nurses. As the nurses increase in size, and their branches touch their principals, let them be pruned or thinned; so as in no way to prevent the principals from being clothed with branches from the ground upwards on every side, or to prevent the leaves on these branches from being fully exposed to the sun. In this way the climate of a plantation will be improved by evergreen nurses; and the nurses will protect the trees from high winds till they have attained to such a size and vigour of growth, that the annual shoots produced on the top of the tree will be so short that they can be ripened in a colder climate than would be required to ripen a longer shoot produced by a young tree. This mode of nursing trees, it may be observed, is widely different from the practice of letting nurses and principals draw up one another, in which case both will be alike without side-branches; and consequently, when the nurses are removed, the principals, weakened by having their stems unprotected by branches exposed to the cold in winter and to the heat in summer, will remain stationary a number of years; in some cases dying away altogether, and in others making so little progress, that nearly as much would be gained in the produce of timber by cutting them down, and training up a single shoot from the stools, or by trenching the ground and replanting, as by letting them grow.

We have now taken a cursory glance at the principal points which require to be considered in the culture of trees, and in the formation and management of plantations; but the subject is of very great extent, and could not be entered into in all the requisite details in even double or treble the space which can be allotted to this article. Our object in writing it has been rather to direct attention to general principles, than to lay down specific rules; satisfied as we are that, in every department of agriculture and gardening, too much deference is paid to routine practices, and too little recourse is had to the principles on which these practices are founded. Above all, planters do not seem sufficiently aware of the important agency of leaves and light, not only in the production of quantity of timber, but of quality also.

It may be necessary to observe, that in this article the botanic names are generally those adopted in Loudon's *Arboretum et Fruticetum Britannicum*, to which work we would refer for more ample information upon all the points which have been here touched on, and on many others directly or indirectly connected with the subject. (V. V. V. V.)

PLANUDES, Maximus, a Greek monk of Constantinople, who, towards the end of the fourteenth century, published a collection of epigrams entitled *Anthologia;* a Greek translation of Ovid's Metamorphoses; a Life of Æsop, which is rather a romance than a history; and some other works. We know nothing more of him, than that he suffered some persecution on account of his attachment to the Latin church.

PLASSEY, a town of Hindustan, in the province of Bengal, and district of Nuddea, situated on the eastern bank of the Bhaggarutty or Hoogly River. Here was fought, in June 1757, between the British under Colonel Clive, and the army of the Nabob Suraje-ud-Dowlah, the battle of Plassey, which ultimately decided the fate of Bengal. Long. 88. 15. E. Lat. 23. 45. N.

PLASTER, or Emplaster, in *Pharmacy*, an external application, of a harder consistence than an ointment, and which is, according to the different circumstances of the wound, place, or patient, spread either upon linen or upon leather.

Plaster, or *Plaister*, in building, a composition of lime, sometimes with sand, or other substance, to parget or cover the nudities of a building.

Plaster of Paris, a preparation of several species of gypsum dug near Montmartre, a village in the neighbourhood of Paris, and hence the name.

The best sort is hard, white, shining, and marbly, being known by the name of *plaster-stone* or *parget of Montmartre.* It will neither give fire with steel, nor ferment with aquafortis; but it calcines very freely and readily into a fine plaster, the use of which in building and casting statues is well known.

The method of representing a face truly in plaster of Paris is this. The person whose figure is designed is laid on his back, with any convenient thing to keep off the hair. Into each nostril is conveyed a conical piece of stiff paper, open at both ends, to allow of respiration. These tubes being anointed with oil, are supported by the hand of an assistant; then the face is lightly oiled over, and the eyes being kept shut, alabaster fresh calcined, and tempered to a thinnish consistence with water, is by spoonfuls nimbly thrown all over the face, till it lies near the thickness of an inch. This matter grows sensibly hot, and in about a quarter of an hour hardens into a kind of stony concretion; which being gently taken off, represents, on its concave surface, the minutest part of the original face. In this a head of good clay may be moulded; and therein the eyes are to be opened, and other necessary amendments made. This second face being anointed with oil, a second mould of calcined alabaster is made, consisting of two parts joined lengthwise along the ridge of the nose; and herein may be cast, with the same matter, a face extremely like the original.

If finely powdered alabaster, or plaster of Paris, be put into a basin over a fire, it will, when heated, assume the appearance of a fluid, by rolling in waves, yielding to the touch, and steaming, all which properties it again loses on the departure of the heat; and being thrown upon paper, it will not at all wet it, but immediately discover itself to be as motionless as before it was set over the fire; wherefore it appears, that a heap of such little bodies as are neither spherical nor otherwise regularly shaped, nor small enough to be below the discernment of the eye, may, without fusion, be made fluid by a sufficiently strong and various agitation of the particles which compose it, and may lose its fluidity when the agitation is discontinued.

Two or three spoonfuls of burned alabaster, mixed up thin with water, in a short time coagulate into a hard lump at the bottom of a vessel full of water. Artificers observe, that the coagulating property of burned alabaster will be very much impaired or lost if the powder be kept too long, especially in the open air, before it is made use of; and when it has been once tempered with water, and suffered to grow hard, they cannot, by any new burning or powdering of it, make it serviceable for their purpose as before.

This matter, when wrought into vessels, or other forms, is still of so loose and spongy a texture, that the air finds an easy passage through it. Mr Boyle, in relating his experiments with the air-pump, gives an account of his preparing a tube of this plaster, closed at one end and open at the other; and on applying the open end to the cement, as is usually done with the receivers, it was found utterly impossible to exhaust all the air out of it; for fresh air from without pressed in as fast as the internal air was exhausted, although the sides of the tube were of considerable thickness. A tube of iron was then put on the engine, so that being filled with water, the tube of plaster of Paris was covered with it; and on using the pump, it was immediately seen that the water passed through into it as easily as the air had done when that was the ambient fluid. After this, trying it with Venice turpentine instead of water, the thing succeeded very well; the tube might be perfectly exhausted, and would remain in that state for several hours. But on pouring some hot oil upon the turpentine, the case was much altered; for the turpentine melting, became a thinner fluid, and in this state was capable of passing like water into the pores of the plaster. On taking away the tube, however, it was remarked that the turpentine, which had pervaded and filled its pores, rendered it transparent, in the manner that water gives transparency to that singular stone called *oculus mundi.* In this manner, the weight of air, under proper management, becomes capable of making several sorts of glues penetrate plaster of Paris; and not only so, but also baked earth, wood, and all other bodies porous enough to admit water.

PLASTIC denotes a thing endowed with a formative power, or a faculty of forming or fashioning a mass of matter after the likeness of a living being.

Plastic *Nature*, a certain power, by which, as an instrument, many philosophers, both ancient and modern, supposed that the great motions in the corporeal world, and the various processes of generation and corruption, were perpetually carried on.

Amongst the philosophers of Greece, such a power was almost universally admitted. It seems, indeed, to have been rejected only by the followers of Democritus and Epicurus, who talk as if they had thought gravity essential to matter, and the fortuitous motion of atoms, which they held to have been from eternity the source, not only of all the regular motions in the universe, but also of the organization of all corporeal systems, and even of sensation and intellection in brutes and in men. It is needless to say, that those men, whatever they might profess, were in reality atheists; and Democritus, it is universally known, avowed his disbelief of a God.

The greater part of the philosophers who held the existence of a plastic nature, considered it not as an agent in the strict sense of the word, but merely as an instrument in the hand of the Deity; although even amongst them there were some who held no superior power, and were of course as gross atheists as Democritus himself. Such was Strato of Lampsacus, a man originally of the peripatetic school, over which he presided many years, with no small degree of reputation for learning and eloquence. He was the first and chief asserter of what has been termed *Hylozoic Atheism;* a system which admits of no power superior to a certain natural or plastic life, essential, ungenerated, and incorruptible, inherent in matter, but without sense and consciousness. That such was his doctrine we learn from Cicero, who makes Velleius the Epicurean say, "Nec audiendus Strato qui Physicus appellatur, qui omnem vim divinam in Natura sitam esse censet, quæ causas gignendi, augendi, minuendive habeat, sed careat omni sensu."[1] That Strato, in admitting this plastic principle, differed very widely from Democritus, is apparent from the following account of him by the same author: "Strato Lampsacenus negat opera deorum se uti ad fabricandum mundum; quæcunque sint, docet omnia esse effecta naturæ, nec ut ille, qui asperis, et levibus, et hamatis uncinatisque corporibus concreta hæc esse dicat, interjecta inani; somnia censet hæc esse Democriti, non docentis sed optantis."[2]

That the rough and smooth, the hooked and crooked, atoms of Democritus, were indeed dreams and dotages, is a position which no man will controvert; but surely Strato was himself as great a dreamer when he made sensation and intelligence result from a certain plastic or spermatic life in matter, which is itself devoid of sense and consciousness. To use the emphatic language of Cudworth, it is indeed inconceivable "how any one in his senses should admit such a monstrous paradox as this, that every atom of dust has in itself as much wisdom as the greatest politician and most profound philosopher, and yet is neither conscious nor intelligent." It is likewise to be observed of Strato, that though he attributed a certain kind of life to matter, he by no means allowed of one common life as ruling over the whole material universe. He supposed the several parts of matter to have so many several plastic lives of their own, and appears[3] to have attributed something to chance in the production and preservation of the mundane system.

In denying the existence of a God, perpetually directing his plastic principle, and in supposing as many of these principles as there are atoms of matter, Strato deviated far from the doctrine of Aristotle. The great founder of the peripatetic school, as well as his apostate disciple, taught that mundane things are not effected by fortuitous mechanism, but by such a nature as acts regularly and artificially for certain ends; yet he never considers this nature as the highest principle, or supreme *Numen*, but as subordinate to a perfect mind or intellect; and he expressly affirms, that "mind, together with nature, formed or fashioned this universe." He evidently considers mind as the principal and intelligent agent, and nature as the subservient and executive instrument. Indeed, we are strongly inclined to adopt the opinion of Mosheim, who thinks that by nature Aristotle meant nothing more than that ϑεϱμοτης ψυχιϰη, or *animal heat*, to which he attributes immortality, and of which he expressly says[4] that all things are full. Be this as it may, he always joins together God and nature, and affirms that they do nothing in vain. The same doctrine was taught before him by Plato, who affirms that "nature, together with reason, and according to it, orders all things." It must not, however, be concealed, that Plato seems to have attributed intelligence to the principle by which he supposed the world to be animated; for Chalcidius, commenting on the *Timæus*,[5] thus expresses himself: "Hæc est illa rationabilis anima mundi, quæ gemina juxta meliorem naturam veneratione tutelam præbet inferioribus, divinis dispositionibus obsequens, providentiam nativis impertiens, æternorum similitudine propter cognationem beata." Apuleius, too, tells us,[6] "Illam cœlestem animam, fontem animarum omnium, optimam virtutum esse genetricem, subserviri etiam Fabricatori Deo, et præsto esse ad omnia inventa ejus."

The doctrine of Plato has been adopted by many moderns of great eminence both for genius and for learning. The celebrated Berkeley, bishop of Cloyne, after describing Plato's *anima mundi*, thus recommends the study of his philosophy:[7] "If that philosopher himself was not read only, but studied also with care, and made his own interpreter, I believe the prejudice that now lies against him would soon wear off, or be even converted into high esteem, for those exalted notions, and fine hints, that sparkle and shine throughout his writings; which seem to contain not only the most valuable learning of Athens and Greece, but also a treasure of the most remote traditions and early science of the east." Cudworth, and the learned author of Ancient Metaphysics, are likewise strenuous advocates for the Aristotelian doctrine of a plastic nature diffused throughout the material world; and a notion very similar occurred to a subsequent writer, who does not appear to have borrowed it either from the Lyceum or the Academy.

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[1] *Natura Deorum*, lib. i. cap. 13.

[2] *Quæst. Acad.* lib. iv. cap. 38.

[3] Cudworth, Intellect. System, ed. Mosheim, lib. i. cap. 3.

[4] *De Generatione Animalium*, lib. iii. c. 11.

[5] Sect. 53.

[6] *De Dogmate Platonis.*

[7] *Siris*, No. 338.

This writer is Mr Young, of whose *active substance*, and its agency in moving bodies, some account has elsewhere been given (see MOTION). As a mere unconscious agent, immaterial, and, as he expresses himself, immental, it bears a striking resemblance to the plastic nature or vegetable life of Cudworth. But the author holds it to be not only the principle of motion, but also the basis or substratum of matter itself; in the production of which, by certain motions, it may be said to be more strictly plastic than the hylarchical principle, or *vis genitrix*, of any other philosopher with whose writings we have any acquaintance. Though this opinion be singular, yet as its author is evidently a man who thinks for himself, unawed by the authority of celebrated names, and as one great part of the utility of such works as ours consists in their serving as indices to science and literature, we shall lay before our readers a short abstract of the reasonings by which Mr Young endeavours to support his hypothesis, and we shall take the liberty of remarking upon those reasonings as we proceed.

The author, after a short introduction, enters upon his work,[1] in a chapter entitled Analysis of Matter in general. In that chapter there is little novelty. He treats, as others have done, of primary and secondary qualities, and adheres too closely to the language of Locke, when he says, that "the nature of bodies signifies the aggregate of all those ideas with which they furnish us, and by which they are made known." To say the best of it, this sentence is inaccurately expressed. An aggregate of ideas may be occasioned by the impulse of bodies on the organs of sense, but the effect of impulse cannot be that which impels. We should not have made this remark, which may perhaps be deemed captious, were we not persuaded that the vague and inaccurate use of terms is the source of those mistakes into which we cannot help thinking that the very ingenious author has sometimes fallen. Having justly observed that we know nothing directly of bodies but their qualities, he proceeds to investigate the nature of solidity.

"Solidity," he says, "is the quality of body which principally requires our notice. It is that which fills extension, and which resists other solids, occupying the place which it occupies; thus making extension and figure real, and different from mere space and vacuity. If the secondary qualities of bodies, or their powers variously to affect our senses, depend on their primary qualities, it is chiefly on this of solidity; which is therefore the most important of the primary qualities, and that in which the essence of body is by some conceived to consist. This idea of solidity has been judged to be incapable of any analysis; but it appears evident to me," continues our author, "that the idea of solidity may be resolved into another idea, which is that of the power of resisting within the extension of body. Hence it becomes unnecessary, and even inadmissible, to suppose that solidity in the body is at all a pattern or archetype of our sensation."

That solidity in the body, and we know nothing of solidity anywhere else, is no pattern of any sensation of ours, is indeed most true, as we have shown at large in another place (see METAPHYSICS); but to reconcile this with what our author asserts immediately afterwards, that "solidity is no more in bodies than colours and flavours are, and that it is equally with them a sensation and an idea," would be a task to which our ingenuity is by no means equal. He affirms, indeed, that solidity, as it is said to be in bodies, is utterly incomprehensible; that we can perfectly comprehend it as a sensation in ourselves, but that in bodies nothing more is required than a power of active resistance to make upon our senses those impressions from which we infer the reality of primary and secondary qualities. This power of resistance, whether it ought to be called active or passive, we apprehend to be that which all other philosophers have meant by the word *solidity;* and though Locke, who uses the words *idea* and *notion* indiscriminately, often talks of the idea of solidity, we believe our author to be the first writer who has thought of treating solidity as a sensation in the mind.

Though it is wrong to innovate in language, when writing on subjects which require much attention, we must, however, acknowledge it to be unworthy of inquirers after truth to dispute about the proper or improper use of terms, so long as the meaning of him who employs them can be easily discovered. We shall, therefore, follow our author in his endeavours to ascertain what this power of resistance is which is commonly known by the name of solidity. All power he justly holds to be active; and having, by an argument[2] of which we do not perceive the force, attempted to prove that it is by an inward power, and not by its *inertia*, that one body prevents another from occupying the same place with itself, he naturally enough infers matter to be essentially active. "But the activity of matter is to be considered in a certain limited sense, and its inertness is to be regarded in another limited sense; so that these are compatible within their respective limits. The activity of body may be considered as belonging to the parts of a compound; its inertia as the inertia formed of those parts. The actions of the parts are everywhere opposed to each other, and equal; and hence results the inactivity of the whole."

Solidity alone of the primary qualities being positive, and peculiar to bodies, and our author having resolved this into *action* or *power*, it follows, by his analysis, that the *essence* of *body* is reduced to power likewise. But, as he properly observes, power is an idea of reflection, not acquired by the senses, but suggested by thought. Hence our knowledge of real existence in body must be such as is suggested to us by our thoughts exercised about our sensations. "We are capable of acting and producing changes in appearances; and this faculty, which we experience to exist in ourselves, we call power. We are conscious of the exertion of our own power; and, therefore, when we see *action* or *change* happen without any exertion of ours, we refer this to other powers without us, and necessarily conclude the power to exist where the change begins or the action is exerted. This power, then, referred to bodies, must exist in them, or it can exist nowhere."

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[1] An Essay on the Powers and Mechanism of Nature.

[2] "We can only conceive of solidity as being a resistance of the parts of any body, to a power which endeavours to separate them, or to bring them nearer together. Now that which resists any power, and prevents its effect, is also a power. By resistance, I mean here an active resistance, such as an animal can employ against an animal. If a horse pulls against a load, he draws it along; but if he draws against another horse, he is put to a stand, and his endeavour is defeated. When any endeavour to change the situation of the parts of any solid is in like manner prevented from taking effect, and the parts retain their situation, the situation has plainly been preserved by an active resistance or power, equivalent to that which was fruitlessly exerted on them."

Such is our author's reasoning to prove that matter is essentially active, and that from this activity results our notion of its solidity; but does he not here confound solidity with hardness, and impenetrability with cohesion? He certainly does; for water is as solid, in the proper sense of the word, as adamant, and the particles of air as the particles of iron. The parts of water are, indeed, separated with ease, and those of adamant with difficulty; but it is not because the latter have more solidity than the former, but because the power of cohesion, whatever it may be, operates upon them with greater force. Solidity is an attribute of a whole; hardness and softness result from the cohesion of parts. We do not at all perceive the propriety of the simile of the horse pulling a load, and afterwards pulling against another horse. Is it because both horses are active that one of them cannot prevail against the other, and because the load is inactive that either of them may drag along a mass of iron of half a ton weight? If so, double or triple the mass, and a very strange phenomenon will be the result; for we shall have an active whole compounded of two or three inactive parts, even though those parts should not be in contact.

In two chapters, which might easily have been compressed into one not so long as the shortest of them, our author analyses atoms or the primary particles of matter, and strenuously opposes their impenetrability. He allows that there are atoms of matter not divisible by any known force; but as these, however small, must still be conceived as having extension, each of them must be composed of parts held together by the same power which binds together many atoms in the same body. This power, indeed, he acknowledges to operate much more forcibly when it cements the parts of a primary atom, than when it makes many atoms cohere in one mass; but still it operates in the same manner; and as the ideal analysis may be carried on *in infinitum*, the only possible idea which is suggested by atoms, or the parts of atoms, is the idea of a resisting power. That this power of resistance, which constitutes what is vulgarly called the solidity of bodies, may not be absolutely impenetrable, he attempts to prove, by showing that resistance does in fact take place in cases where impenetrability, and even solidity, are not supposed by any man.

"Let us endeavour," says he, "to bring together two like poles of a magnet, and we shall experience a resistance to their approximation. Why, then, may not a piece of iron, which between our fingers resists their coming together, resist by an efficacy perfectly similar, though more strongly exerted? If magnetism were to act upon our bodies as upon iron, we should feel it; or were magnets endowed with sensation, they would feel that which resists their nearer approach. The resisting extension between the two magnets is permeable to all the rays of light, and, reflecting none, is therefore unseen; but it is easy to conceive that the same power which resists the approach of the iron might resist and reflect some rays of light. We should then have a visible object interposed between the two magnets, as we have before supposed it might be a tangible one. It is likewise easy to conceive that which is tangible and visible so applied to our organs of tasting, of smelling, and of hearing, as to excite ideas of flavours, odours, and sounds. Thus we see that an action, in which no supposition of solidity or impenetrability is involved, may be conceived to assume all the qualities of matter, by only supposing a familiar effect extended in its operation."

This reasoning is exceedingly ingenious, though perhaps not original; but, what is of more importance, it does not approach so near to demonstration as the author seems to imagine. If magnets operate by means of a fluid issuing from them (see MAGNETISM), those who hold the solidity or impenetrability of matter will maintain, that each atom of the magnetic fluid is solid and impenetrable. That we do not see nor feel these atoms, will be considered as no argument that they do not exist; for we do not see, nor in a close room feel, the atoms of the surrounding atmosphere; which yet Mr Young will acknowledge to have a real existence, and to be capable of operating upon our senses of hearing and smelling. Let us, however, suppose that by this reasoning he has established the non-existence of everything in the primary atoms of matter except active powers of resistance, and let us see how he conceives the actions of these powers to constitute what gives us the notion of inert and solid body; for that we have such a notion cannot be denied.

To *act* he allows to be an attribute, and justly observes, that we cannot conceive an attribute to exist without a substance. "But," says he, "we have traced all phenomena to action as to a generic idea, comprehending under it all forms of matter and motion as species of that genus. By this analysis, that complex idea we have usually denominated matter, and considered as the substance or substratum to which motion appertained as an attribute, is found to change its character, and to be itself an attribute of a substance essentially active, of which one modification of motion produces matter and another generates motion." The action of this substance Mr Young determines to be motion; and he proceeds to inquire by what kind of motion it produces matter, or inert and resisting atoms.

"Whatever portion of the *active substance* is given to form an atom, the following things are necessary to be united in such portion of active substance. *First*, It must in some respect continually move; for otherwise it would lose its nature, and cease to be active. *Secondly*, It must also in some other respect be at rest, for otherwise it could not form an inactive atom. *Thirdly*, It must preserve unity within itself." The author's proof of the first of these positions we have given elsewhere; the second he holds to be self-evident; and the third he thinks established by the following reasoning. "Solidity is the result of those actions among the parts of any whole, whereby the unity of the whole is preserved within itself. Several uncohering things may be united by an external bond; this does not constitute these one solid; it may be one bundle; but if several things cohere, and have an unity preserved within themselves, they become one solid. An atom is the least and most simple solid."

Having thus proved the necessity of these three requisites to the formation of an atom, he observes that "the two first can only be united in a rotation of the portion of active substance about a centre or axis at rest. By such a motion, all the parts successively occupy different places in the orbit of rotation, and therefore move; the centre round which they revolve being at rest, the whole portion is also at rest; and thus the portion is at once moving and quiescent, as is required. The same kind of motion will also fulfil the terms of the third requisite; for a substance having a revolving motion around its own centre, preserves its unity by reason of all the parts preserving the same relation to the centre; and further, a motion of the active substance about a centre or axis will be an activity in the same orbit, which will act upon and resist whatever shall interfere to oppose its activity, or destroy the unity of the sphere, by diverting the course of the revolving motions. The activity or motion of a portion of *active substance* about a centre will, therefore, give solidity to such portion; for it will give it unity and resistance, and in a manner tie together all the parts, forming them into one mass about their common centre; for they move or are active, not towards the centre, in which case they would be lost in non-extension; nor from the centre, where they would dissipate in boundless space; but about the centre, preserving the same limits of extension. And being in this way active, they in this way resist any other activity opposed to them, that is, they resist any action which tends to penetrate or divide this sphere of revolving activity. Therefore, since any portion of active substance does, by revolving about a centre, become an united, resisting, and quiescent whole, the smallest portions of the *active substance* which have such motions will become atoms, or make the smallest portions of matter."

Having thus shown to his own satisfaction how atoms of matter are formed, he next explains, what at first he confesses may appear to be a paradox, "how the *active substance*, retaining its own nature and essential properties, continuing immaterial, unsolid, and active, puts on at the same time the form of matter, and becomes material, solid, and inert. A sphere of revolving active substance, as it revolves constantly about a centre, and as parts of the substance are considered as successively passing through every point in the orbit; considered thus in its parts, and in its motions, it is *active substance*, immaterial, and unsolid; but the whole sphere, considered unitically, collectively, and as quiescent, is in this point of view a solid atom, material and inert."

Such is the active substance of Mr Young, and such his theory of the formation of matter. That he has not with servility copied from the ancients, every reader of his book, who is not an absolute stranger to Greek and Roman literature, will readily acknowledge; and yet, if his theory be well founded, he has discovered a middle substance between mind and matter, more properly plastic than Aristotle or Plato, Cudworth or Berkeley, ever conceived. But truth compels us to add, that to us his theory appears to labour under insuperable objections. That there may be in the universe a substance essentially active, and at the same time not intelligent, is a proposition which we are by no means inclined to controvert. Various phenomena, both in vegetable and in animal life, lead us to suspect that there is such a substance; but it does not follow that we are inclined to adopt our author's doctrine respecting the formation of matter. He conceives his proof indeed to be "in its nature not at all imperfect, or to fall short of demonstration; and if any one refuse it, he thinks it will be necessary for him to show, either that the explanation offered is not sufficient, or that some other explanation will serve equally well."

To show that the explanation which this writer has offered is not sufficient, will not, we apprehend, be a very arduous task; but we have ourselves no inclination to attempt another explanation, because we believe that of the formation of matter no other account can be given than that which resolves it into the fiat of the Creator. That it cannot be formed by the motion of an immaterial substance, in the manner which our author has very clearly described, seems to be a truth so evident as not to admit of proof; for if motion, as he defines it, be a change of place, everything that is moved must have the quality of extension. But all the parts of this active substance which are given to form an atom, move round a centre, and are expressly said to occupy successively different places in the orbit of rotation. Every one of these parts, therefore, is an extended being: And since, according to our author, solidity is nothing but an active power of resistance, and the parts of this active substance, in their rotation round their centre, act upon and resist whatever interferes to oppose their activity, it follows that each of these parts is likewise a solid being. But, in the opinion of Mr Young himself, and of all mankind, whatever is extended and solid is material. This theory, therefore, exhibits a process in which atoms are formed of a substance which, though it is said to be active, immaterial, and unsolid, appears, when narrowly inspected, to be nothing else than a collection of those very atoms of which the author pretends to explain the formation. Mr Young, who examines and very freely censures some of the doctrines of Newton and others, can scarcely have expected that others would refrain from stating objections to a theory which is quite new, to a transformation which he himself acknowledges may to many "appear not only problematical and difficult to conceive, but wholly impossible, and implying contradictions absolutely and for ever irreconcileable." Whether this be a just character of it our readers must determine; but if we had not believed the author to be a man of ingenuity, we should not have introduced him or his work to the notice of the public.

END OF VOLUME SEVENTEENTH.

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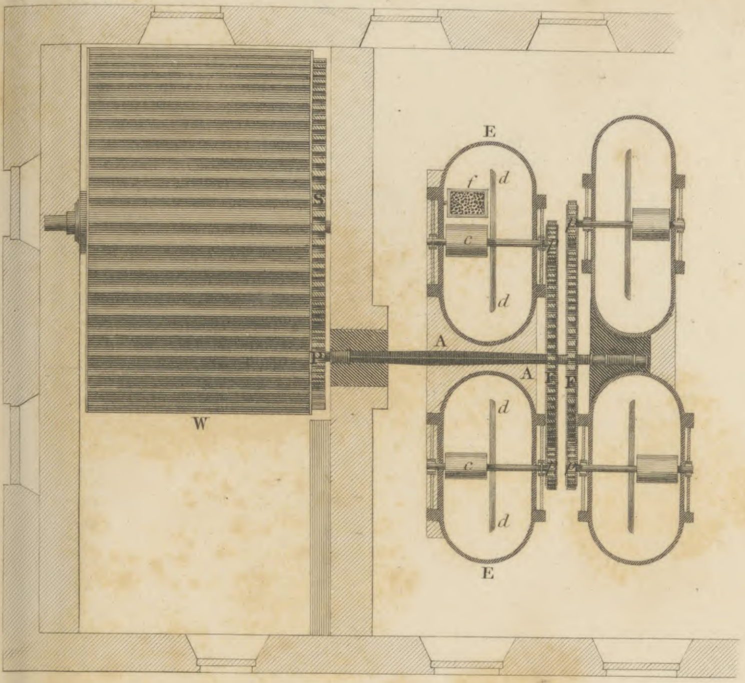
PAPER.

PLATE CCCCIII.

Fig. 1.



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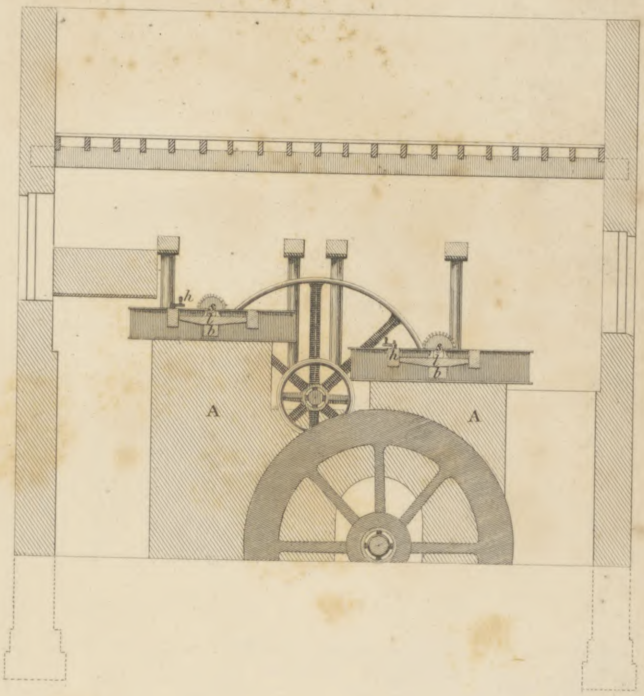

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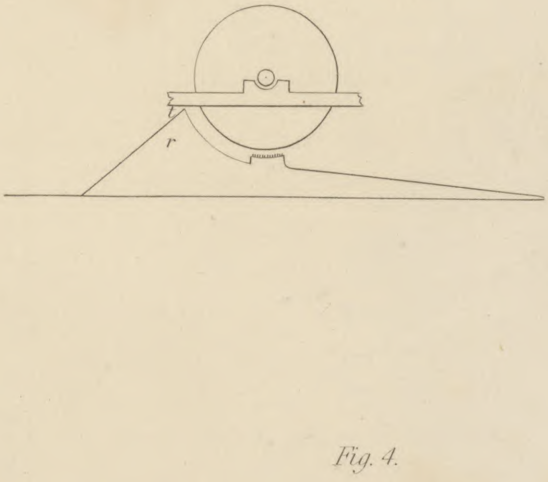

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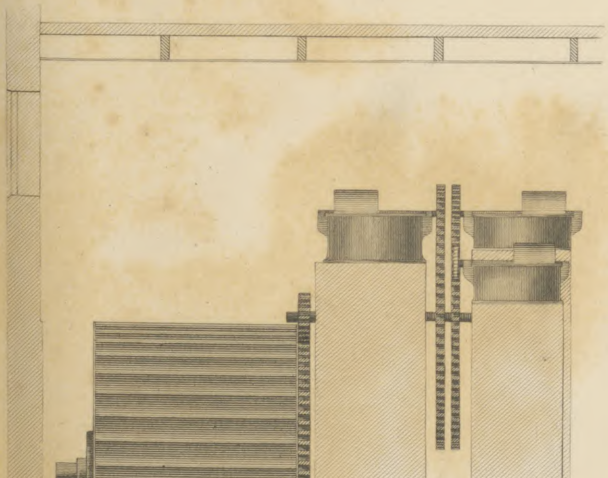

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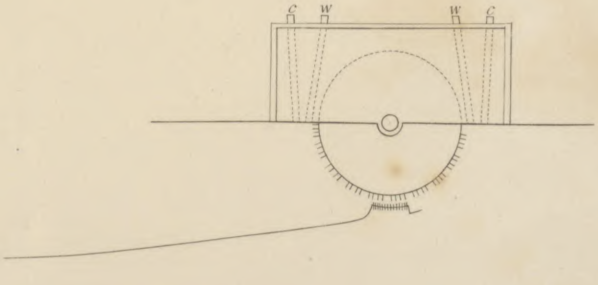


Geo. Aikman, Sculp!

References to the Cutting Machine.

Z. *Crank placed on the main shaft connected by a rod with a quadrant which regulates the length of the sheets, each revolution of the crank giving a sheet which is longer or shorter as the rod is fixed nearer the centre of the shaft.*

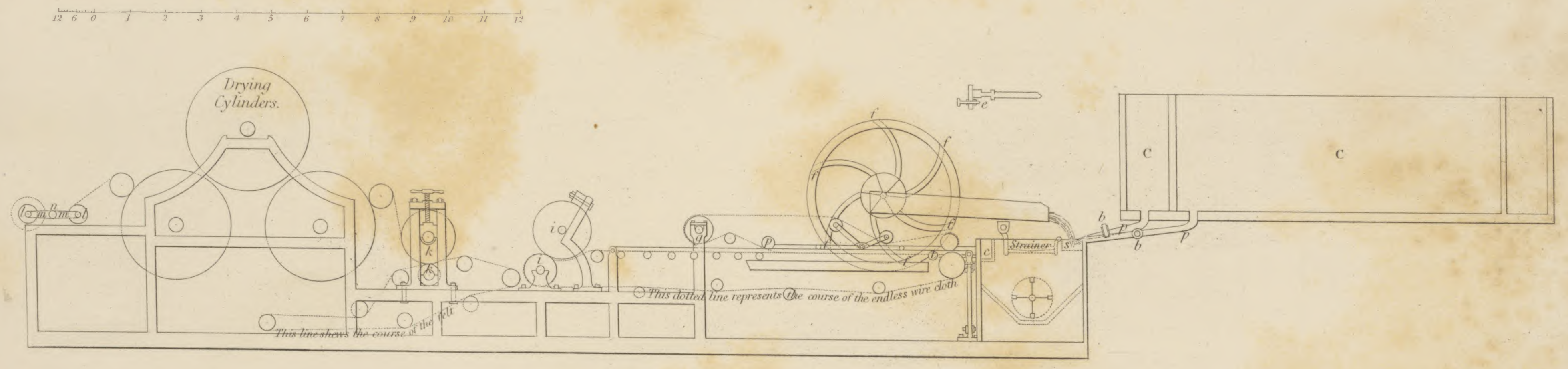
K. *Knife which divides the sheet transversely, being lifted by a wiper or cone fixed on the shaft; and after the cut is made it is brought to its place by a balance weight.*

r. r. r. *Reels containing the Paper in webs for being cut.*

P. *Paper after being cut.*

f. f. f. *Felt to keep the Paper tight to the Drum.*

FOURDRINIER'S PAPER MACHINE.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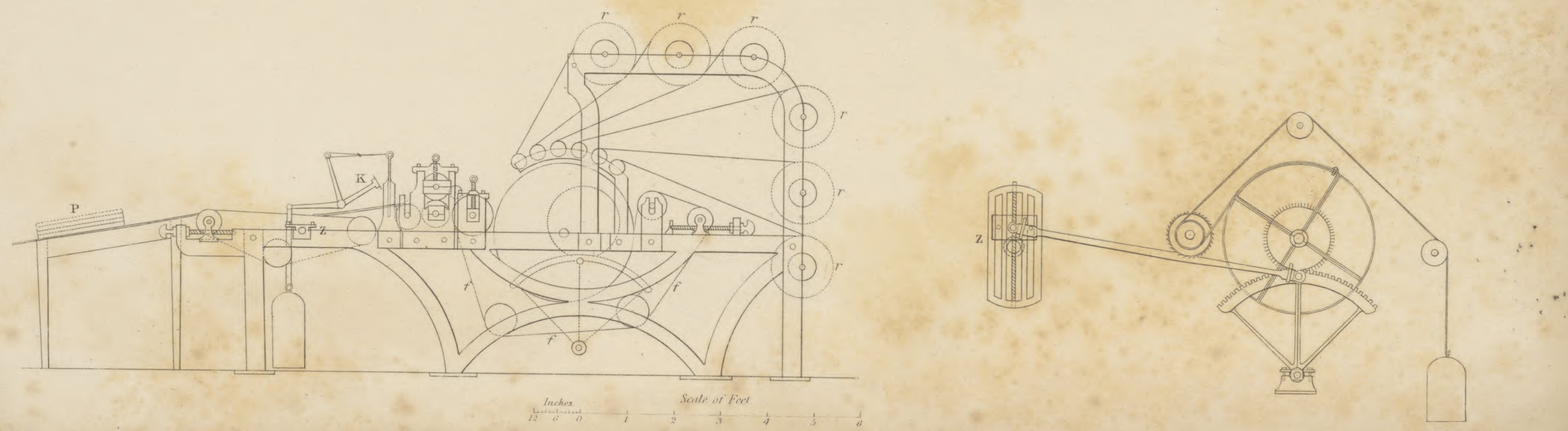
This line shews the course of the felt

FOURDRINIER'S CUTTING MACHINE.



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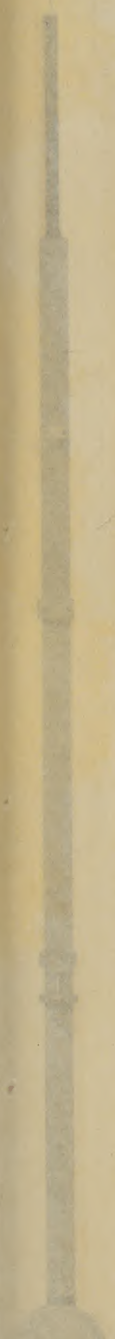

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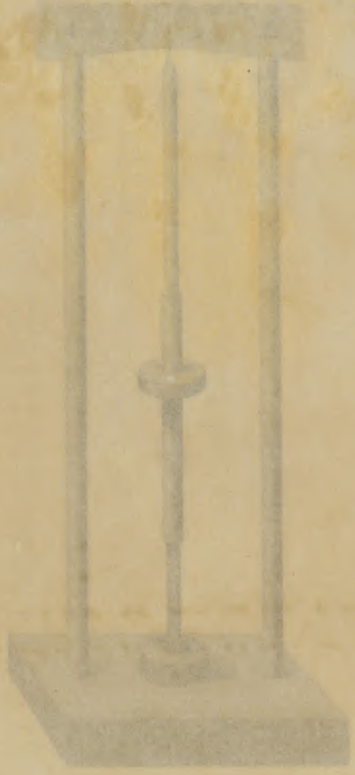

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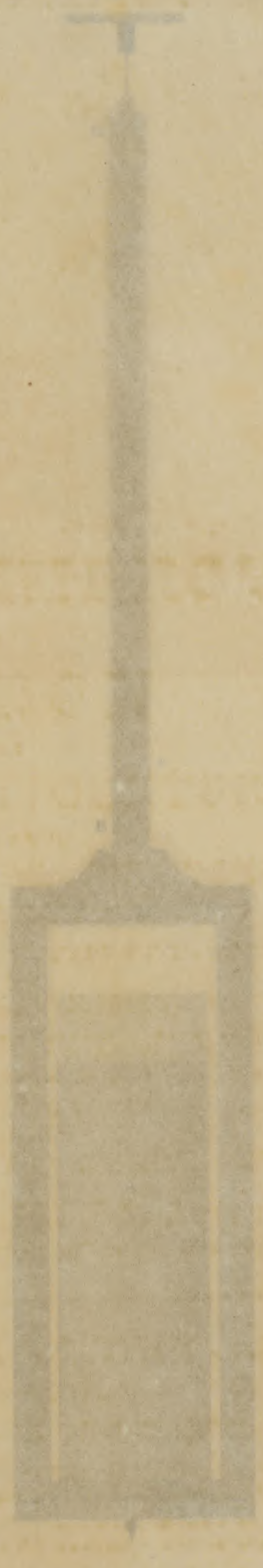

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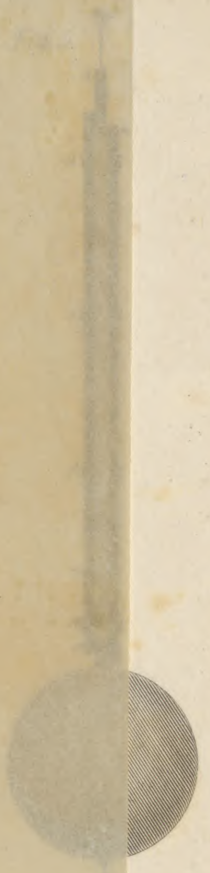

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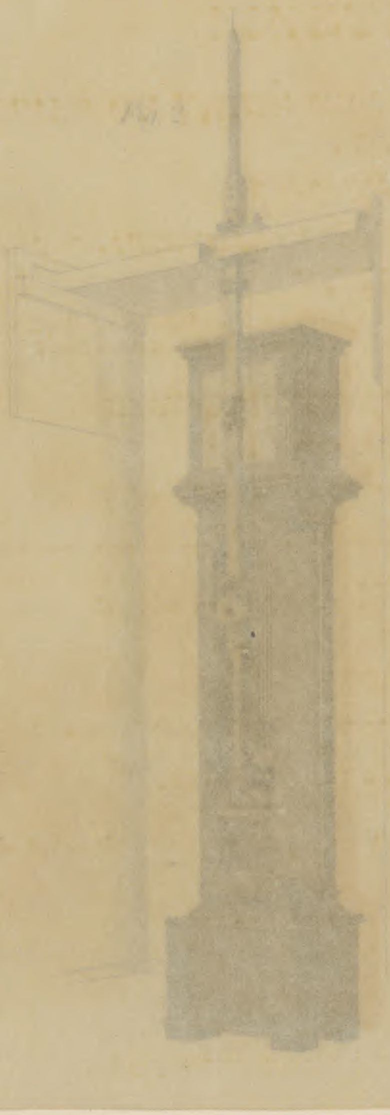

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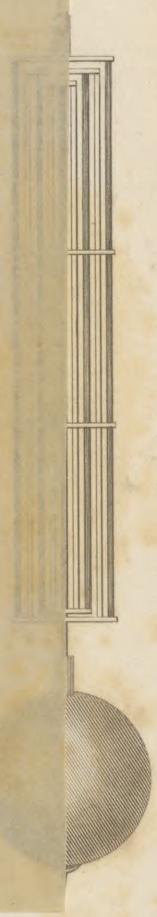

Fig 4.

Geo. Aikman, Sculpt.

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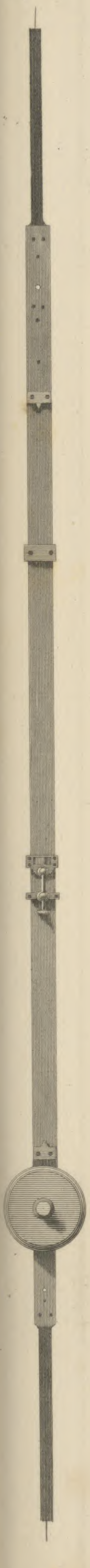

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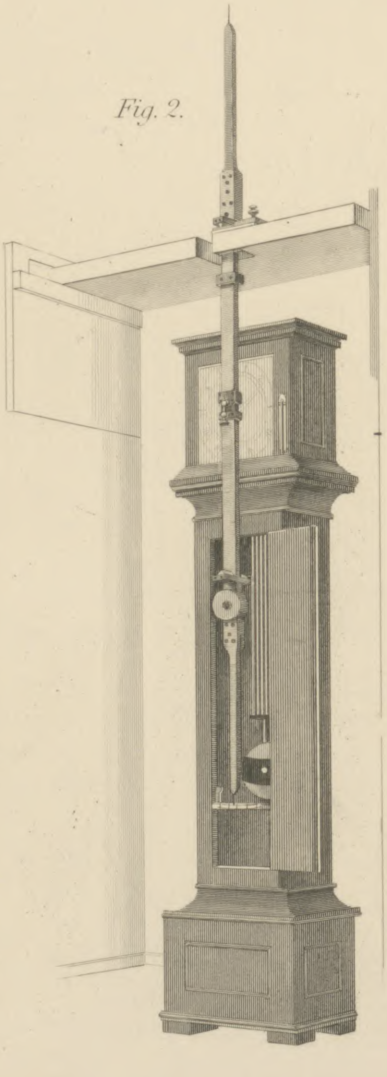

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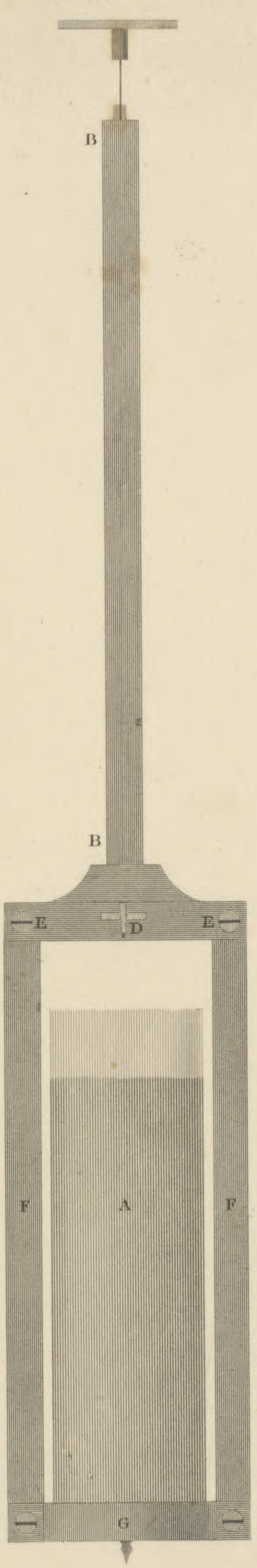

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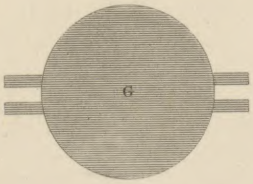
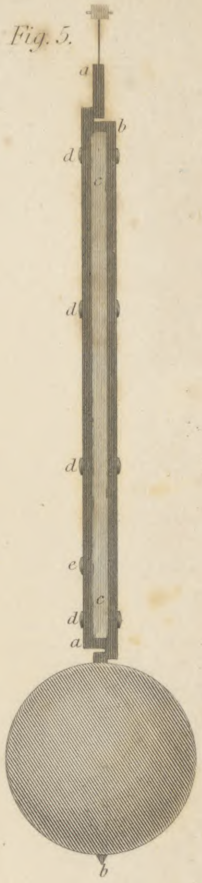


Fig. 5.



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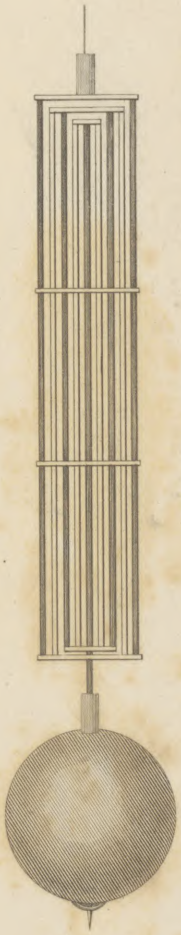

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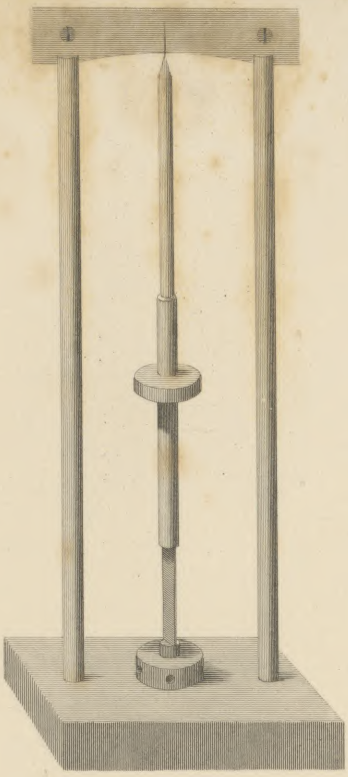
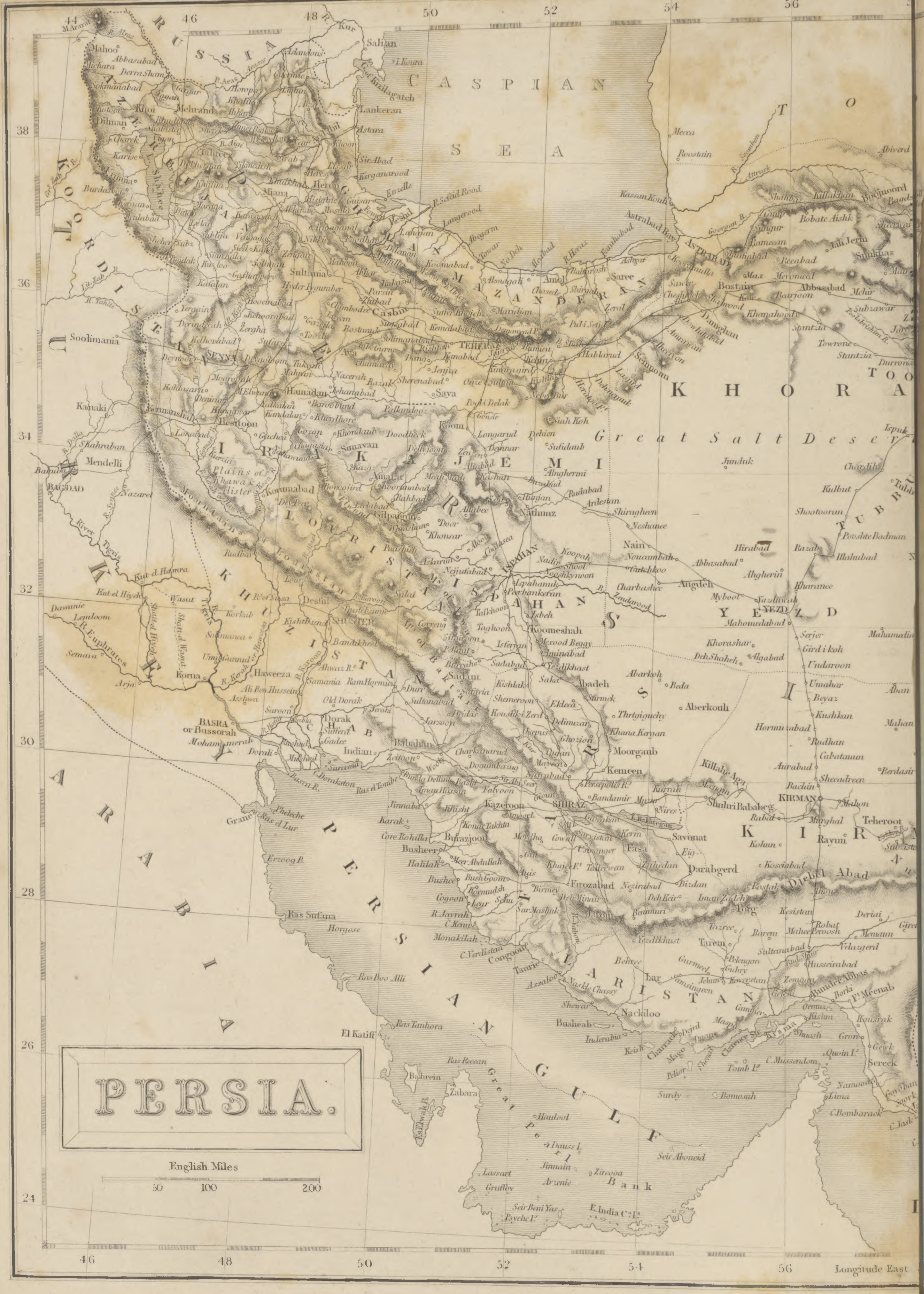


Geo. Aikman, Sculpt.



PERSIA.

English Miles
50
100
200
Longitude East
44
46
48
50
52
54
56
38
36
34
32
30
28
26
24
RUSSIA
CASPIAN SEA
AZERBIJAN
GHILAN
MAZANDERAN
KOORDISTAN
IRAK AJEMI
LOURISTAN
KHUZISTAN
FARSISTAN
LARISTAN
KHORASAN
KIRMAN
YEZD
TURKISTAN
ARABIA
PERSIAN GULF
Great Salt Desert
Great Pearl Bank
M. Ararat
Salian
Lankeran
Astara
Tabreez
Miana
Reshd
Enzelle
Sultania
Casbin
TEHERAN
Demavend P.
Astrabad
Astrabad Bay
Bostam
Damghan
Abbasabad
Sebzawar
Soolimania
SENNA
Kermanshah
Hamadan
Sava
Koom
Kashan
Bagdad
Mendelli
Gilpaigun
ISPAHAN
Nain
Yezd
Shuster
Desful
Kut el Hamra
Korna
Basra or Bussorah
Mohammerah
Bahahan
Shiraz
Kazeroon
Busheer
Firozabad
Darabgerd
Kirman
Lar
Gombroon
Bundar Abbas
Ormuz
Kishm
Nackiloo
Congoon
El Katiff
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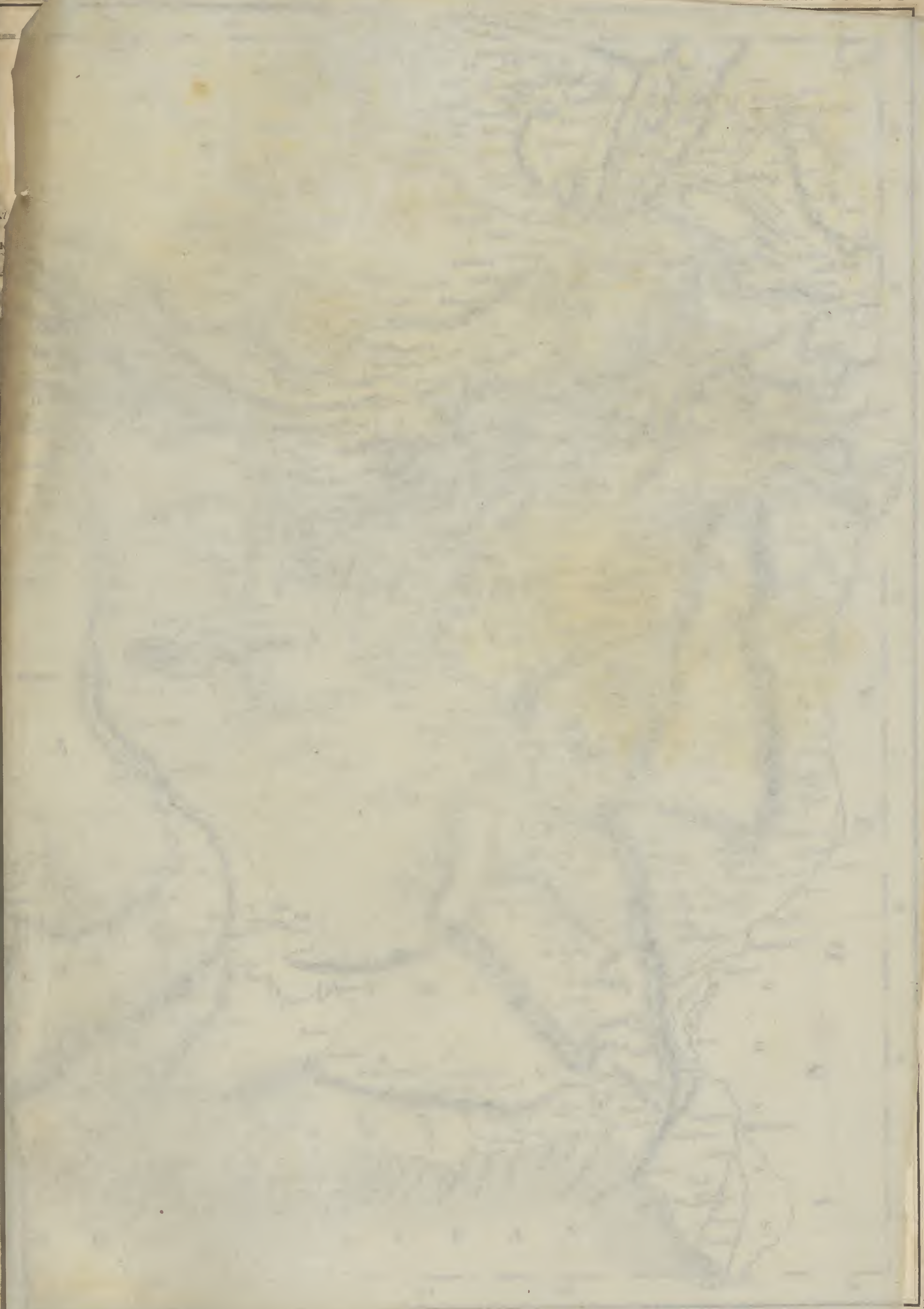
Zabara
Ras Sufana
Grane
C. Mussendom
Tomb I.
E. India Co. I.
Seir Aboneid



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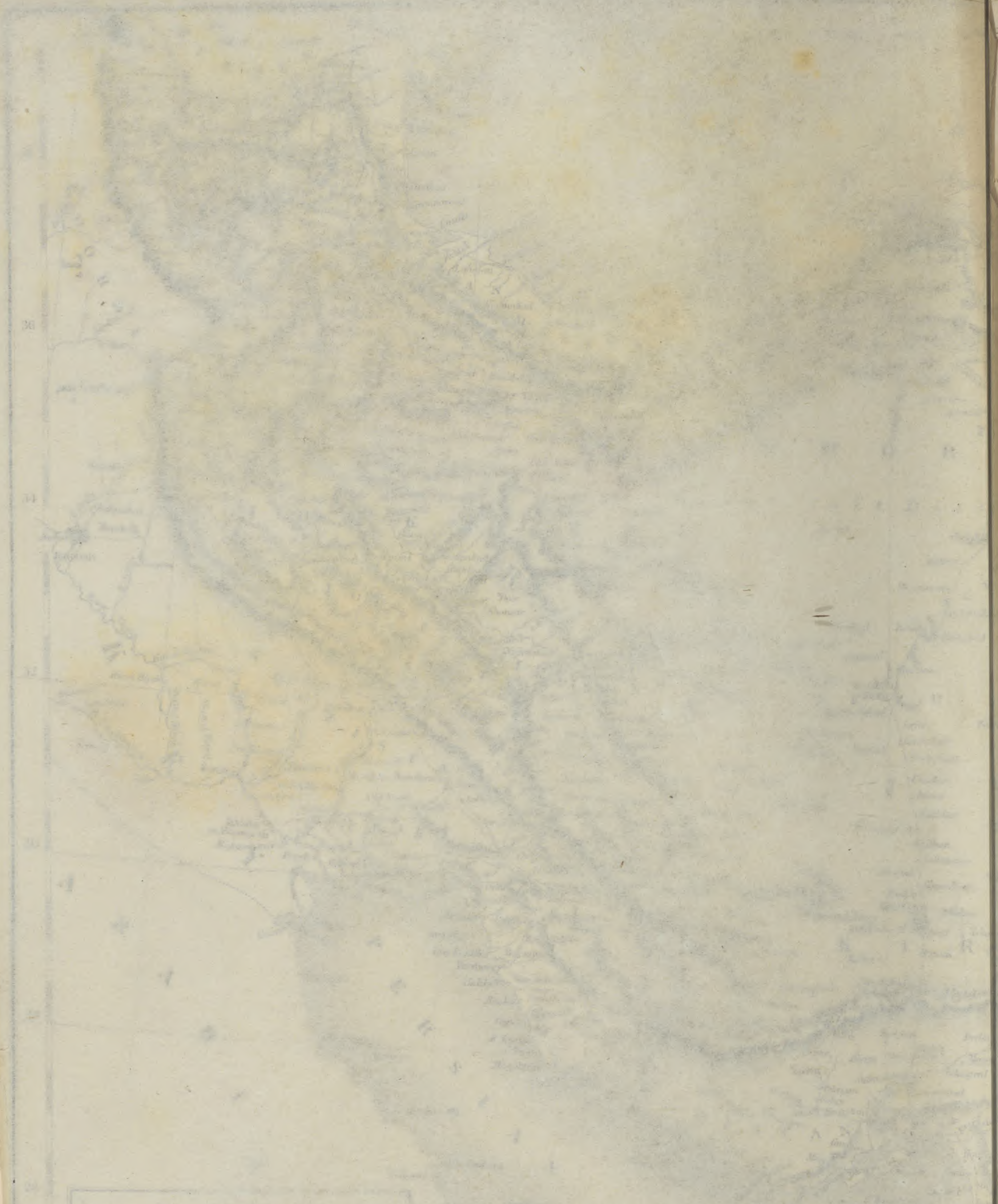
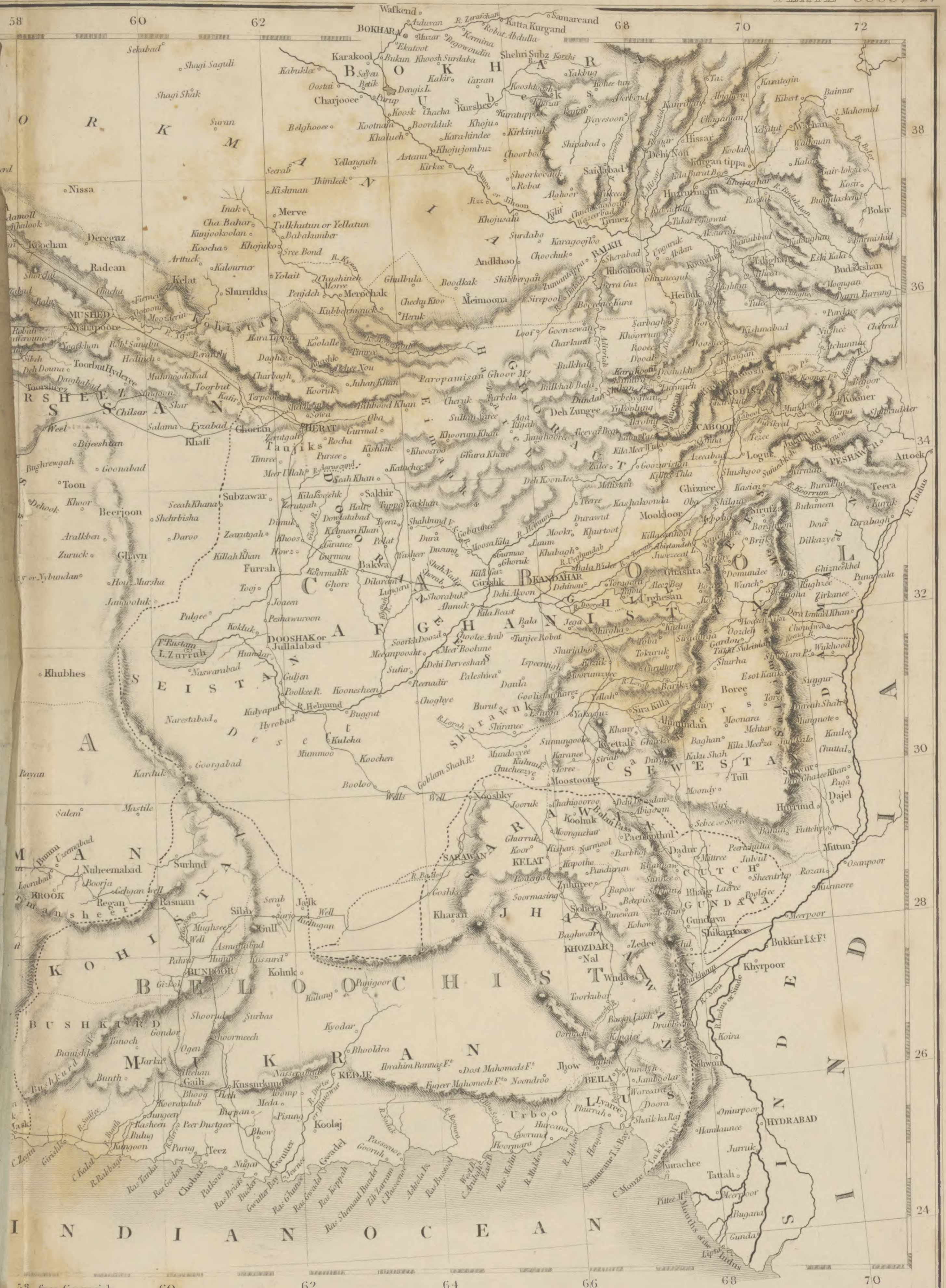
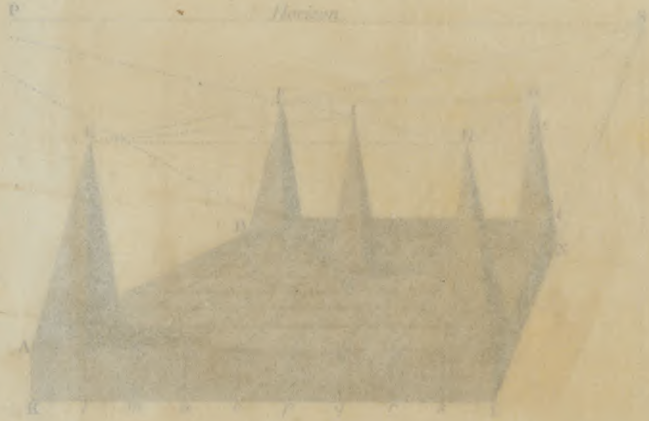

PERSIA
English Miles
36
34
32
30
28
26



Engraved by S Hall Bury St. Bloomsbury

Fig. 1.



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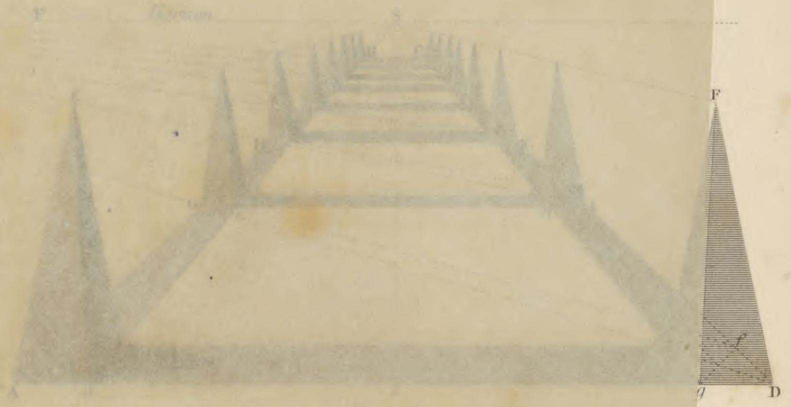
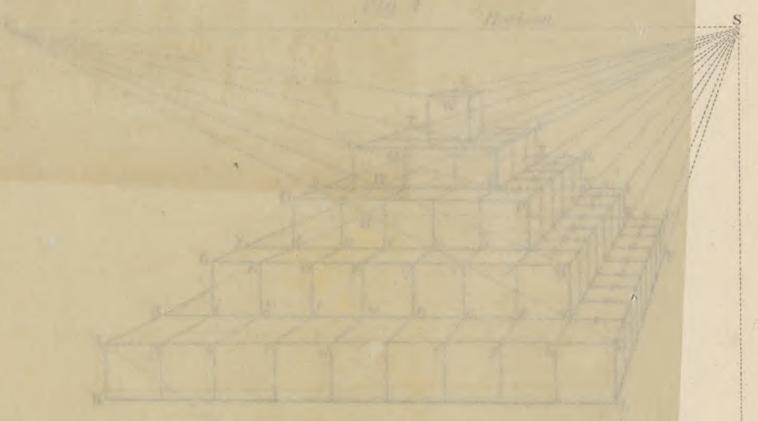


Fig. 3.

Fig. 4.



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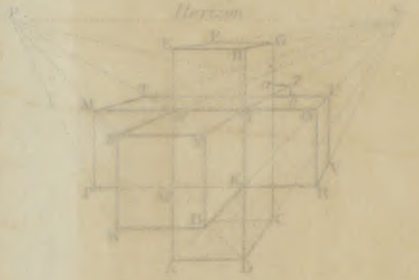


Fig. 6.

Fig. 8.

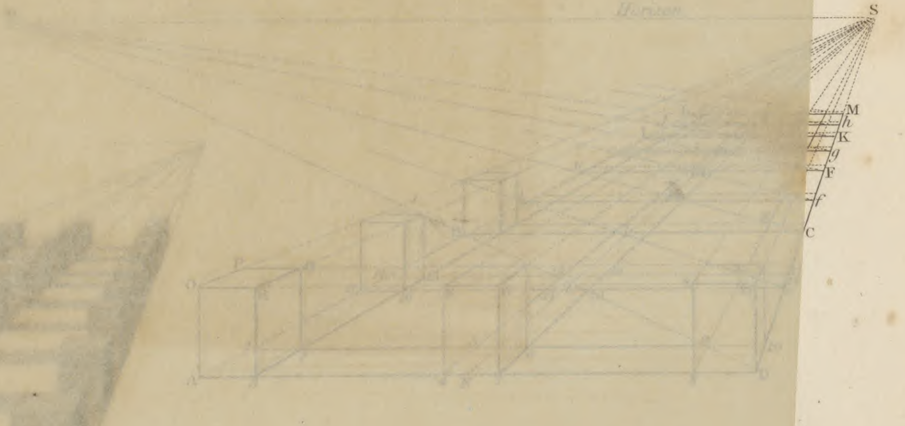
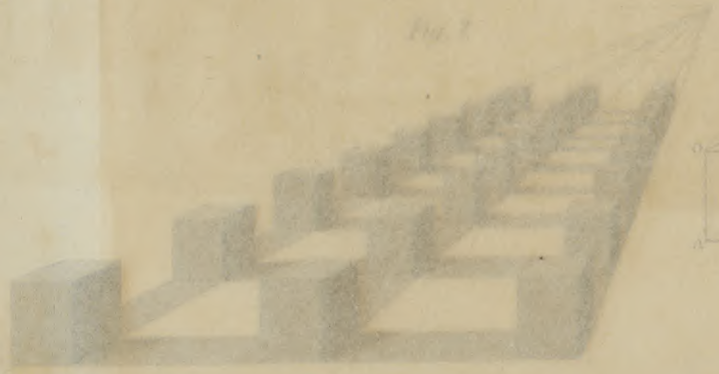


Fig. 7.



Geo. Aikman, Sculp.t

Fig. 1.

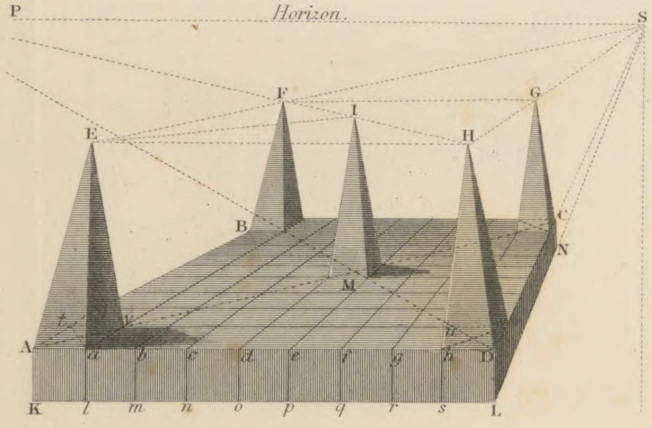


Fig. 2.

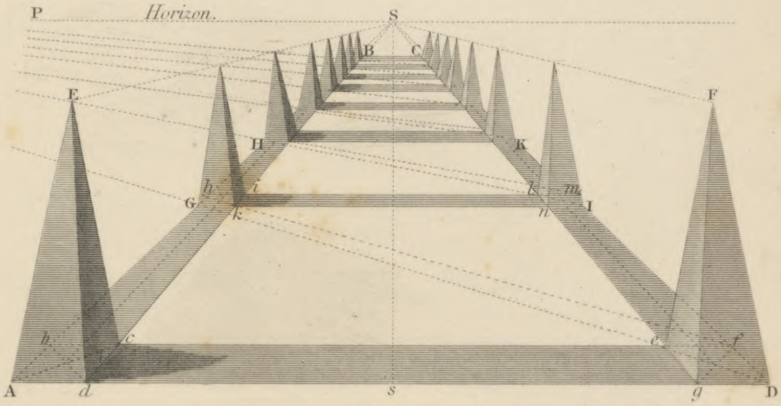


Fig. 3.

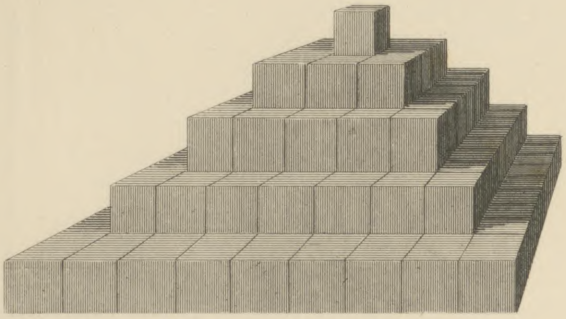


Fig. 4.

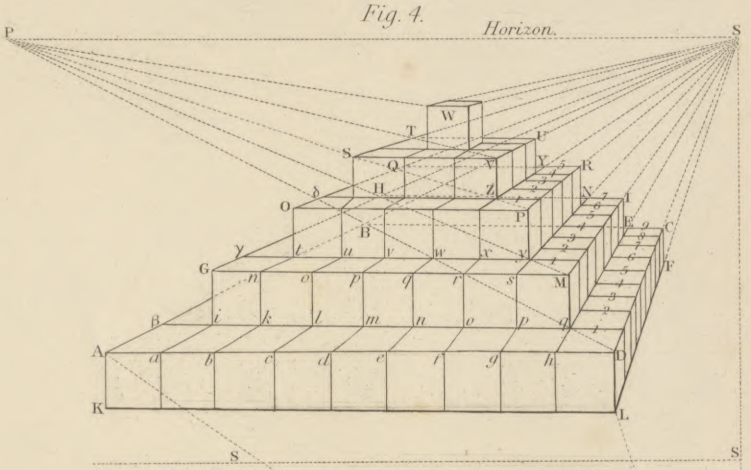


Fig. 5.

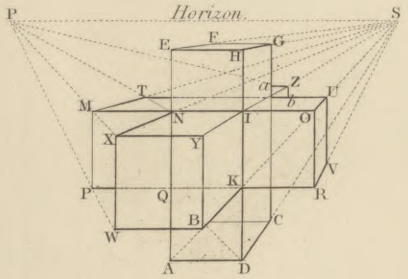
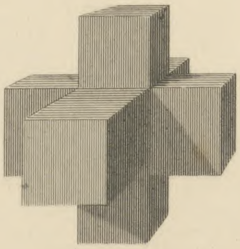


Fig. 6.



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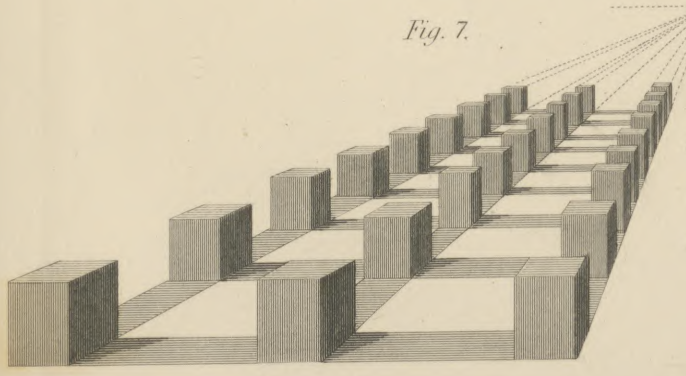

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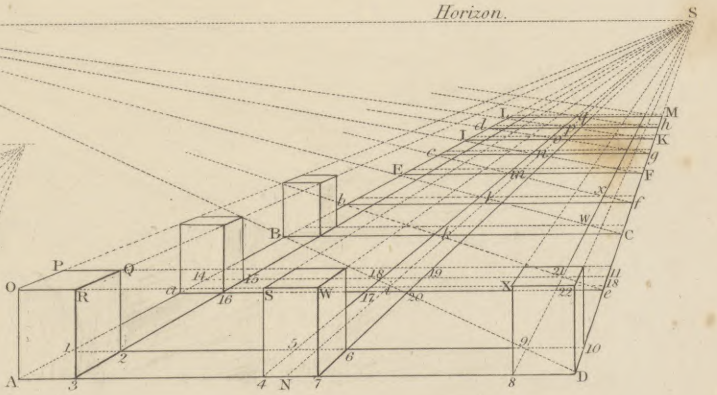


Geo. Aikman, Sculpt.

Fig. 8

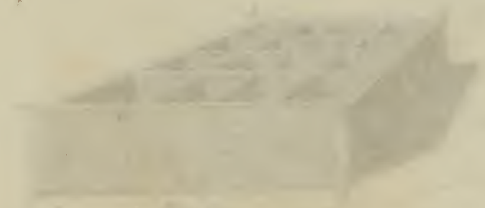


Fig. 9

Fig. 10

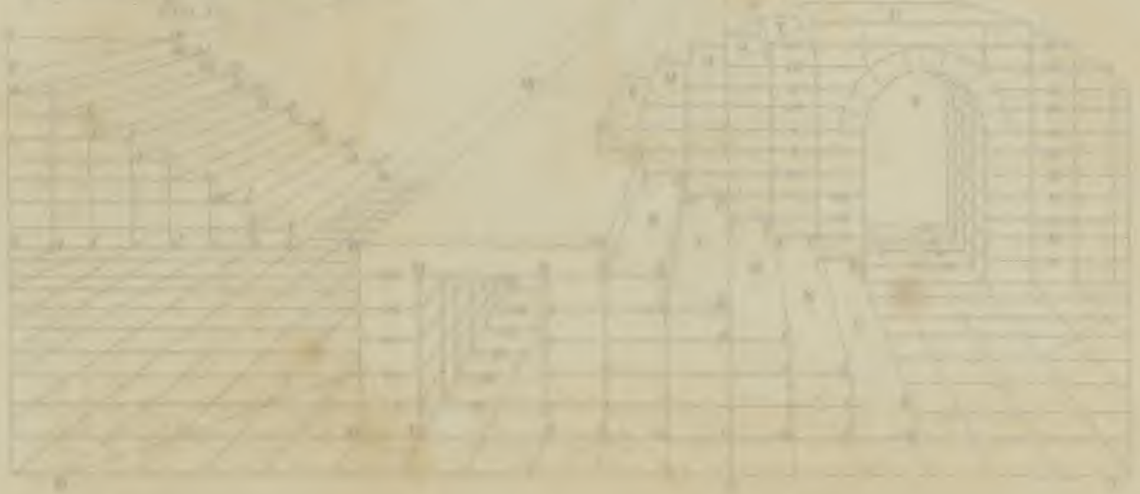


Fig. 11

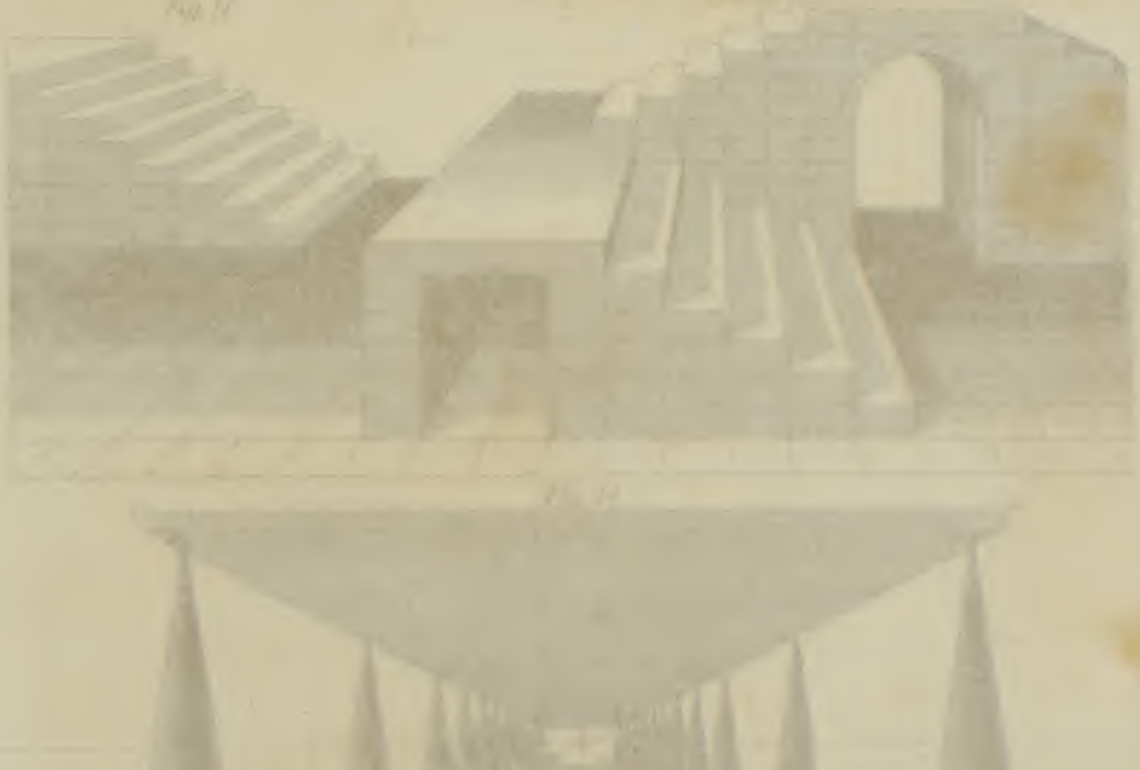


Fig. 14

Geo. Aikman Sculp^t

PERSPECTIVE.

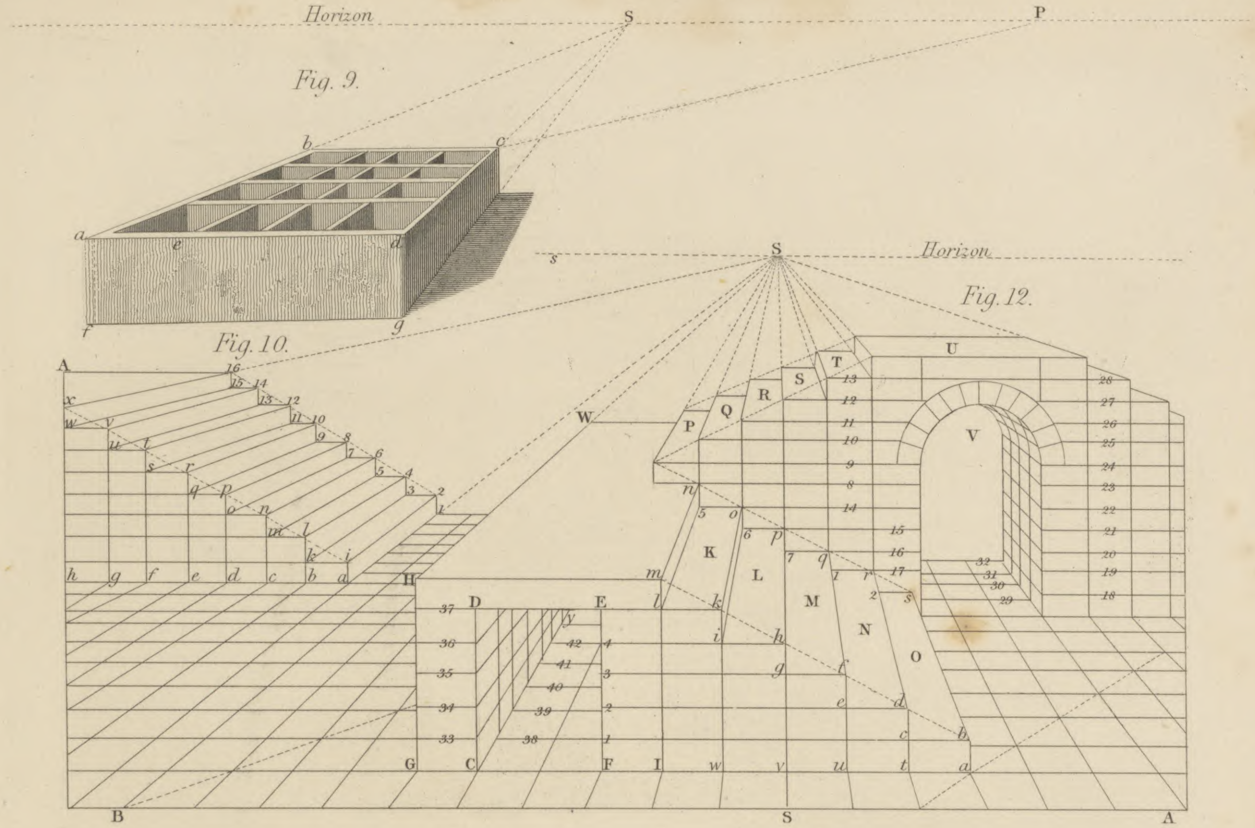


Fig. 9.

Fig. 10.

Fig. 12.

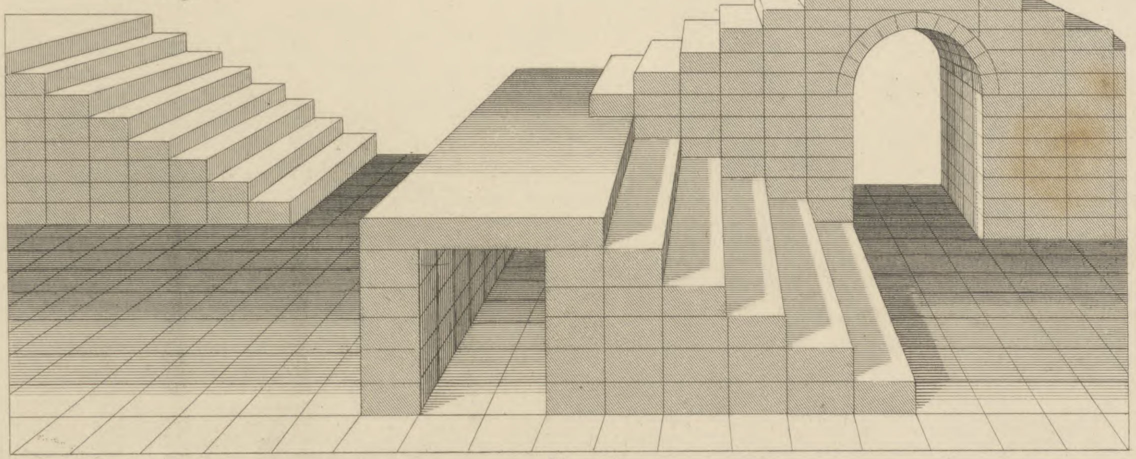


Fig. 11.

Fig. 13.

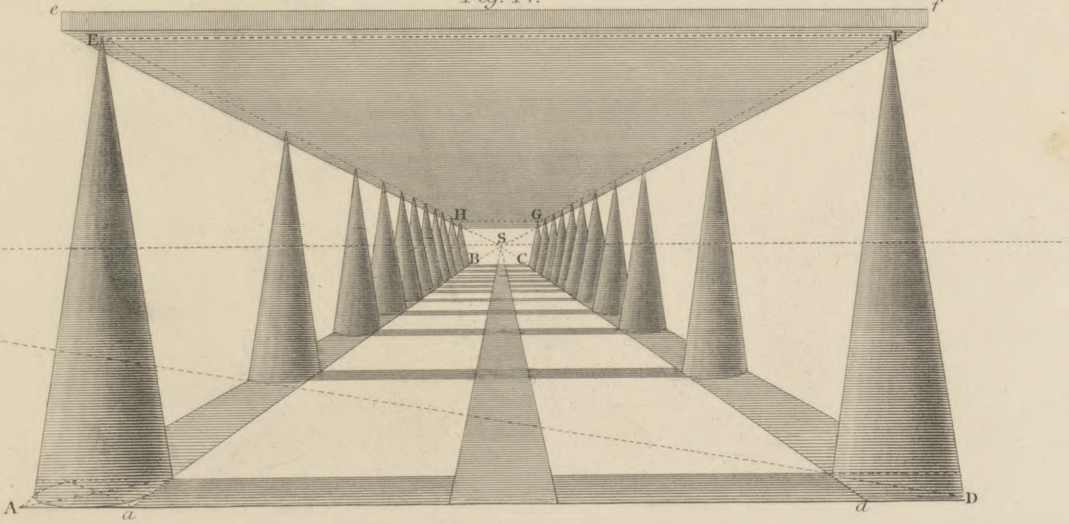
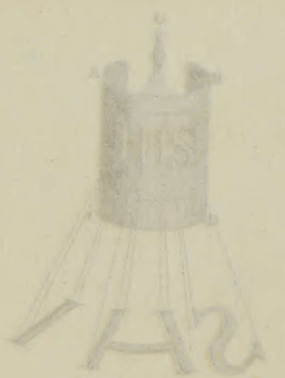


Fig. 14.

Geo. Aikman, Sculpt.

Fig. 16.



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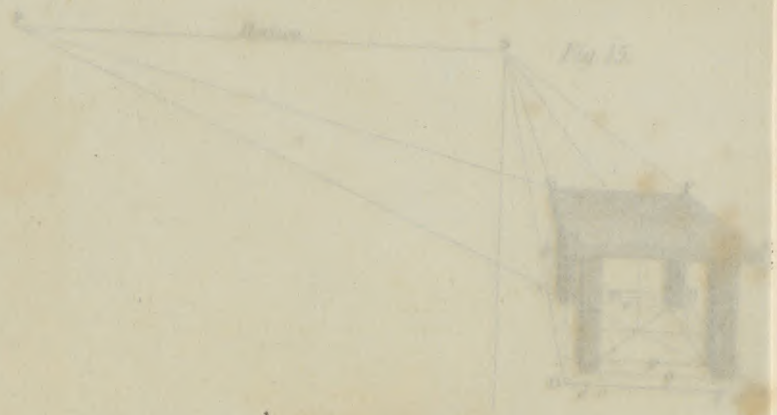

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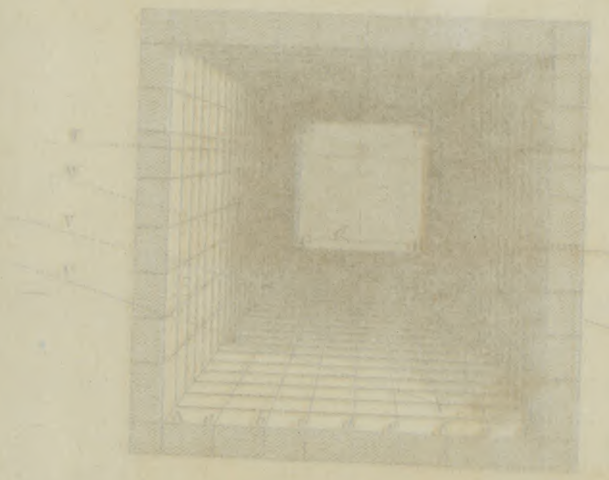

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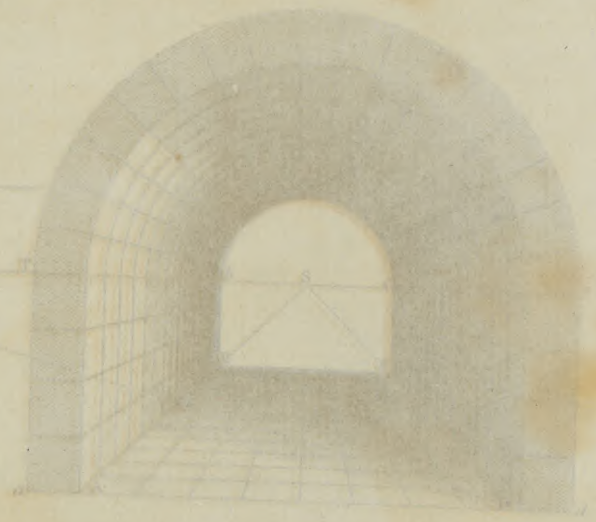

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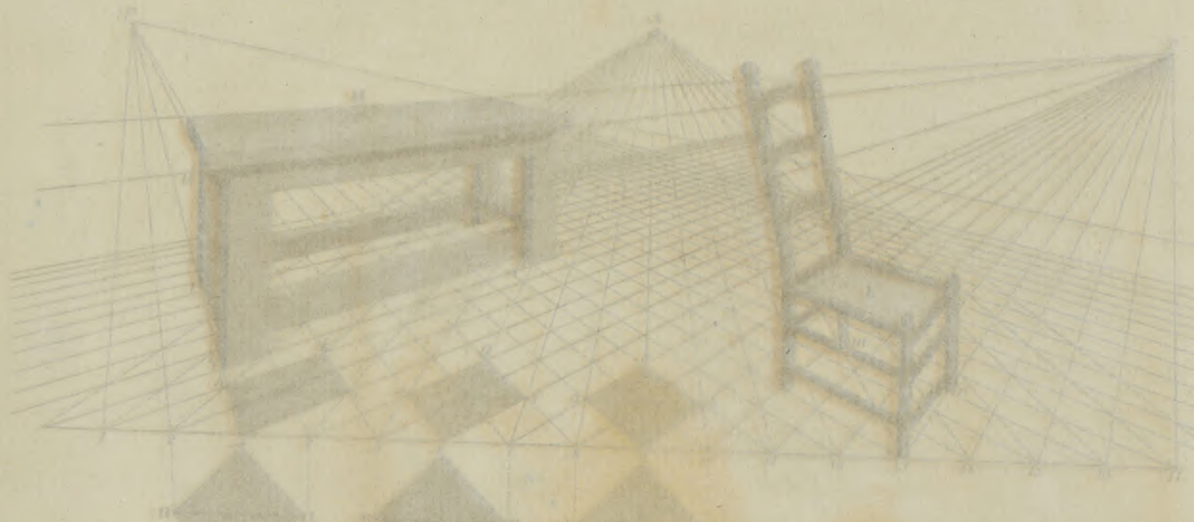


o Aikman, Sculpt

PERSPECTIVE.

PLATE CCCCVIII.

Fig. 16.

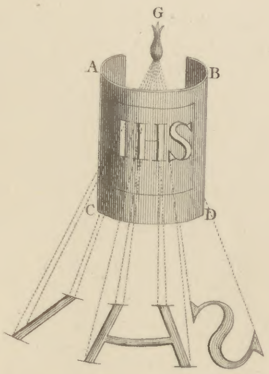


Fig. 15.

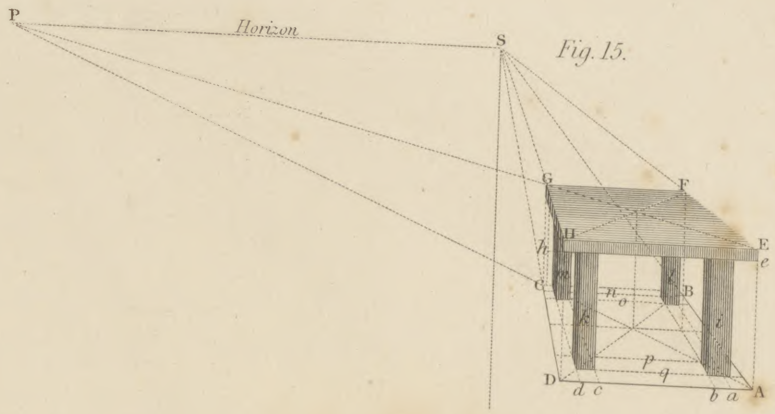


Fig. 17.

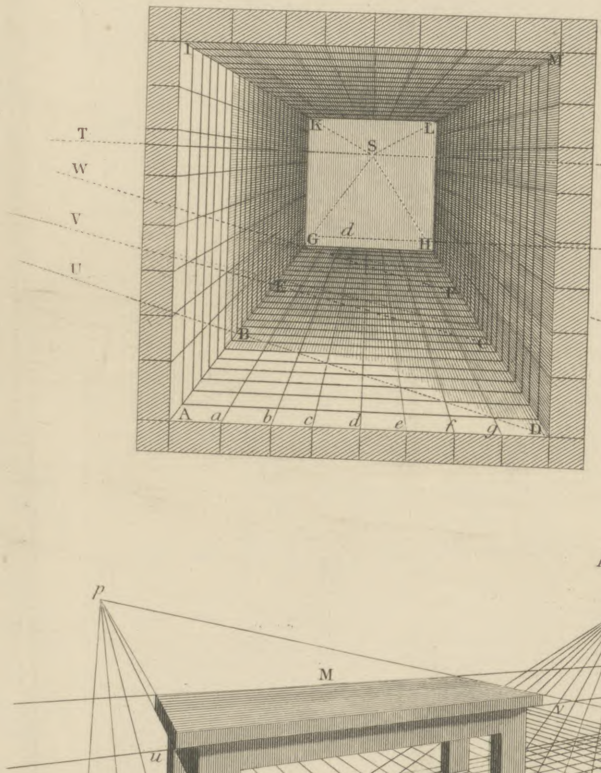
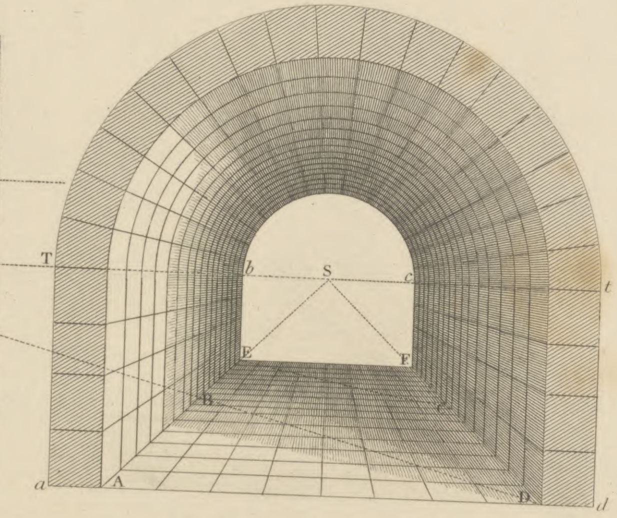


Fig. 18.



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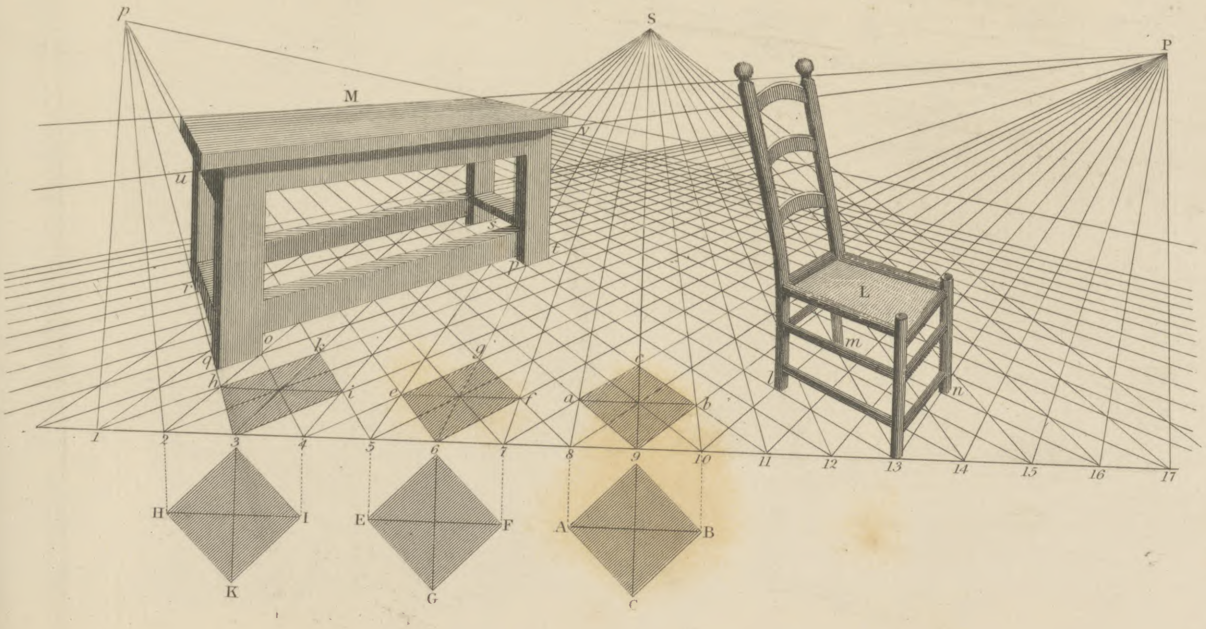
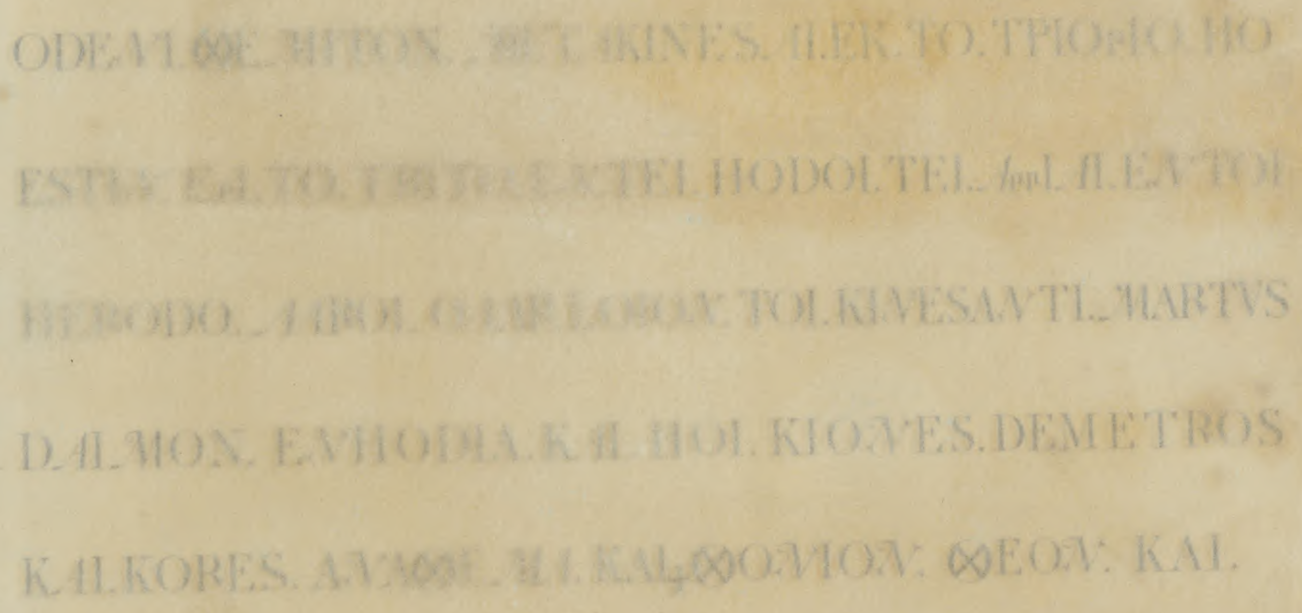


Geo. Aikman, Sculp.t

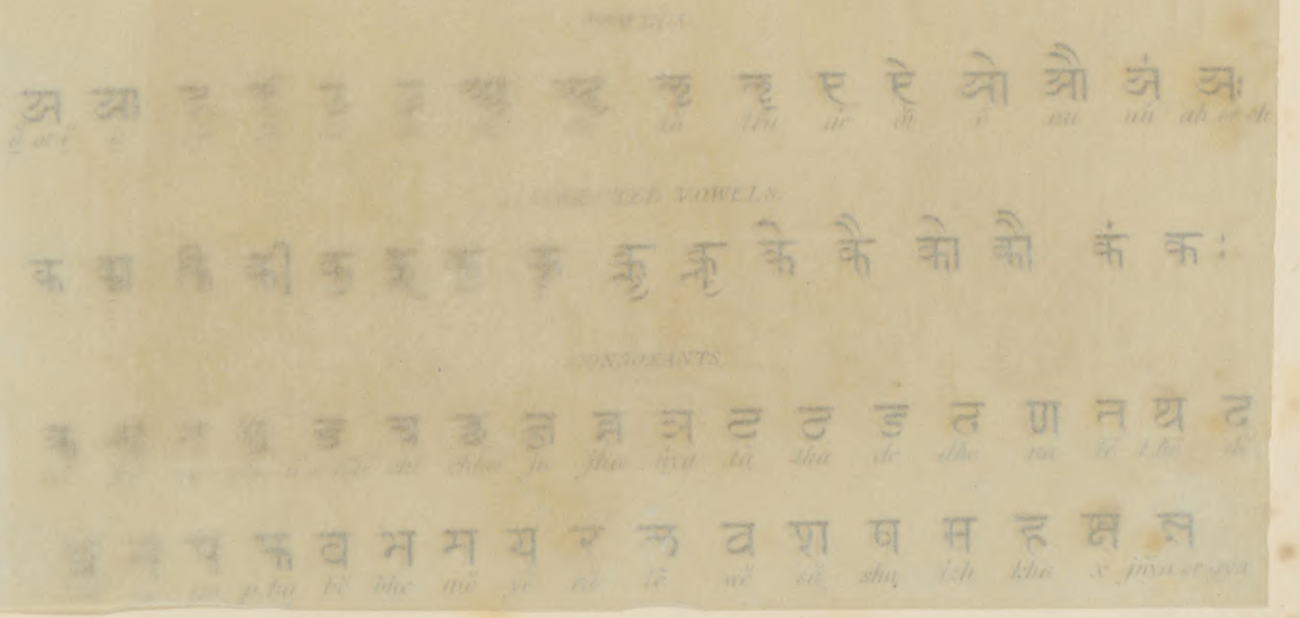
EXEMPLUM ATTICARUM PRISCARUM.

[illegible]

[illegible]


ODEAΓ.ΘE.MEDON...KINES.ILEK.TO.TPIO.IO.HO
ESTI.A.EA.TO.ΕΚΤΕΙ.HODOI.TEI...I.ILEA.TOI
HERODO...KINESANTI..MARTVS
DAI.MON.EVHODIA.KAI.HOI.KIOΛES.DEMETROS
KAI.KORES.AVAΘE.MA.KAI.ΘEO.ΛΙΟΝ.ΘEOΛ.KAI.

SANSCRIT ALPHABET.

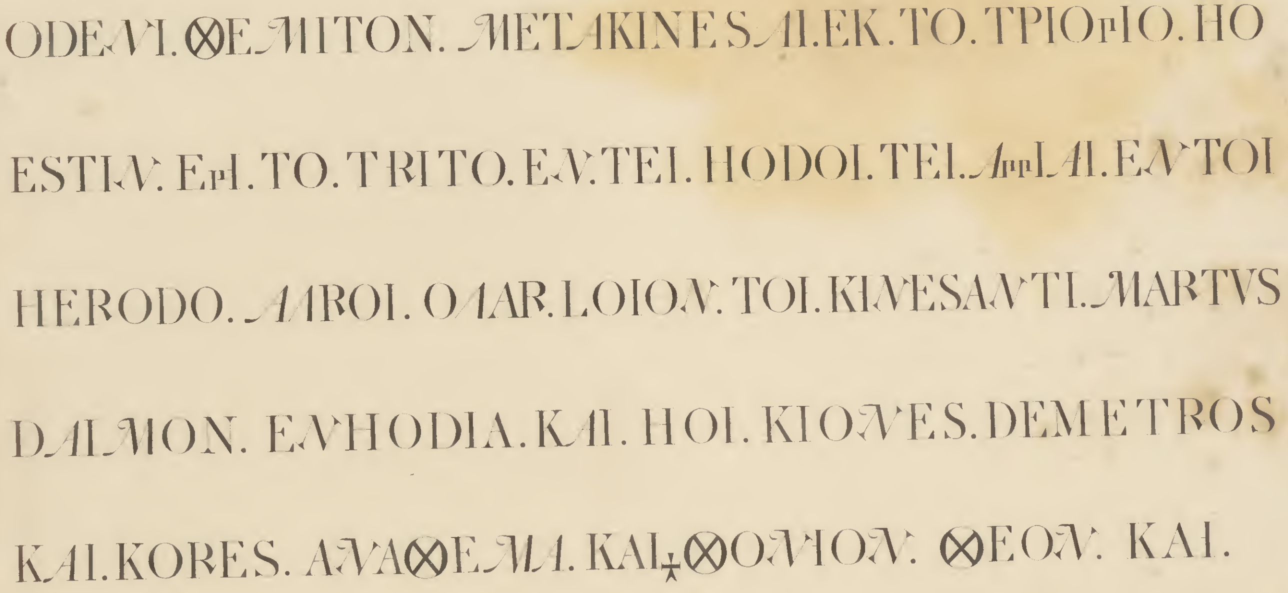

VOWELS.
अ आ इ ई उ ऊ ऋ ॠ ऌ ॡ ए ऐ ओ औ अं अः
COMBINED VOWELS.
क का कि की कु कू कृ कॄ कॢ कॣ के कै को कौ कं कः
CONSONANTS.

Geo. Aikman, Sculp.

EXEMPLUM IONICARUM PRISCARUM.

LITERARUM EX COLUMNA, QUÆ IN VIA APPIA REPERTA,

POSTEA AD HORTOS FARNESIANOS TRADUCTA EST.



ODENI. ⊗EMITON. METAKINESAI. EK. TO. TPIOΓIO. HO

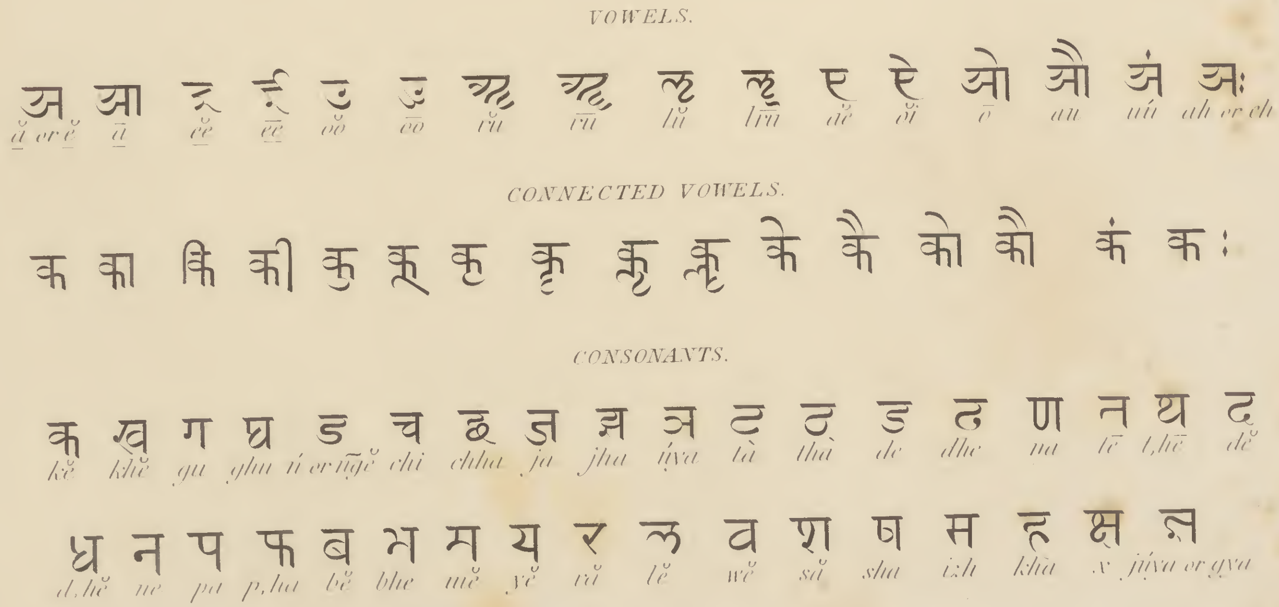
ESTIN. EΓI. TO. TRITO. EN. TEI. HODOI. TEI. AΓΓIAI. EN TOI

HERODO. AΓROI. OΓAR. LOION. TOI. KINESANTI. MARTVS

DAIMON. ENHODIA. KAI. HOI. KIONES. DEMETROS

KAI. KORES. ANA⊗EMA. KAI. ⊗ONION. ⊗EON. KAI.

SANSCRIT ALPHABET.



VOWELS.

अ	आ	इ	ई	उ	ऊ	ऋ	ॠ	ऌ	ॡ	ए	ऐ	ओ	औ	अं	अः
ă or ĕ	a	ĕe	ēē	ŏŏ	ōo	rŭ	rū	lŭ	lrū	aĕ	ăĭ	ō	au	ún	ah or eh

CONNECTED VOWELS.

क का कि की कु कू कृ कॄ कॢ कॣ के कै को कौ कं कः

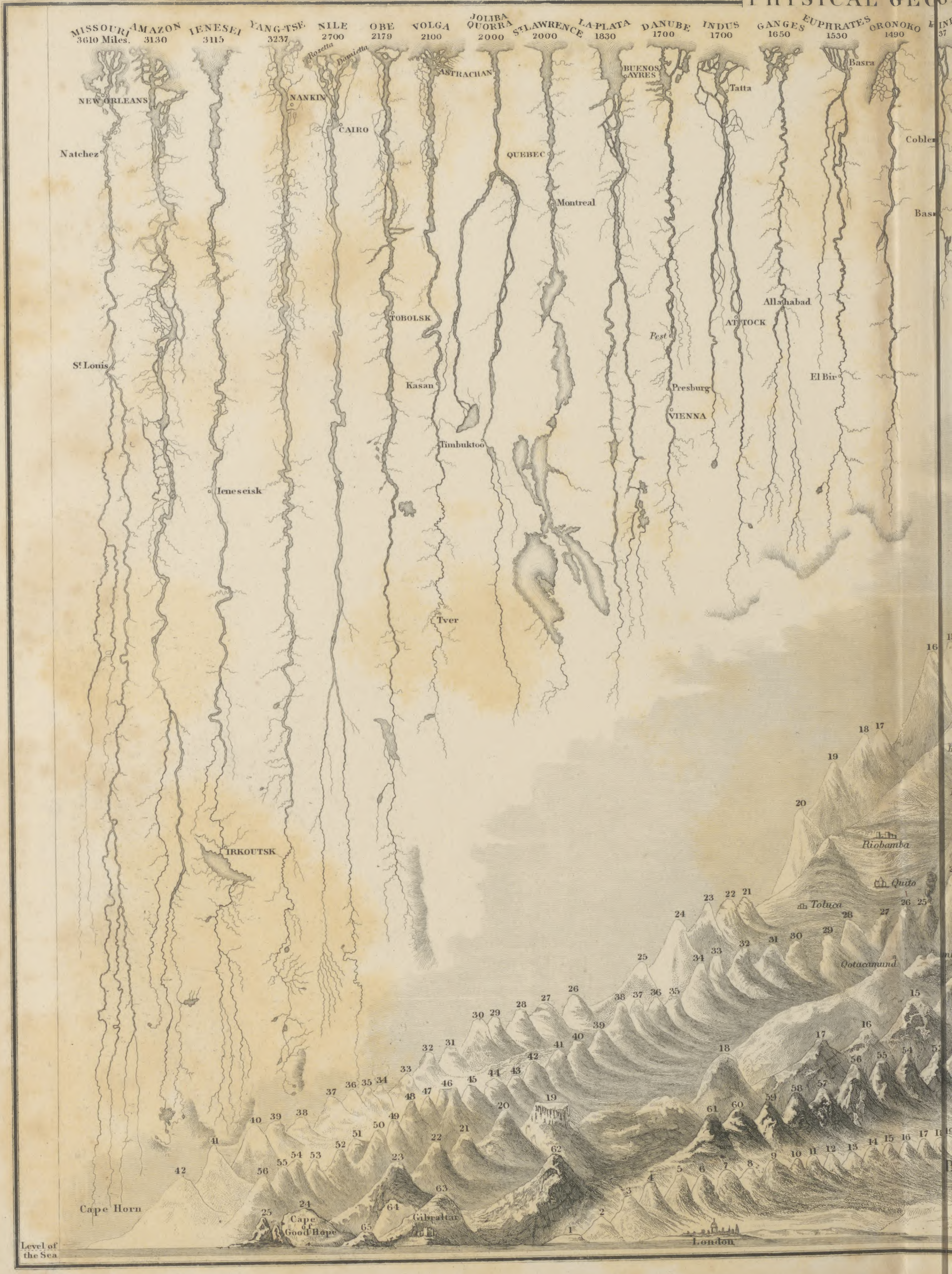
CONSONANTS.

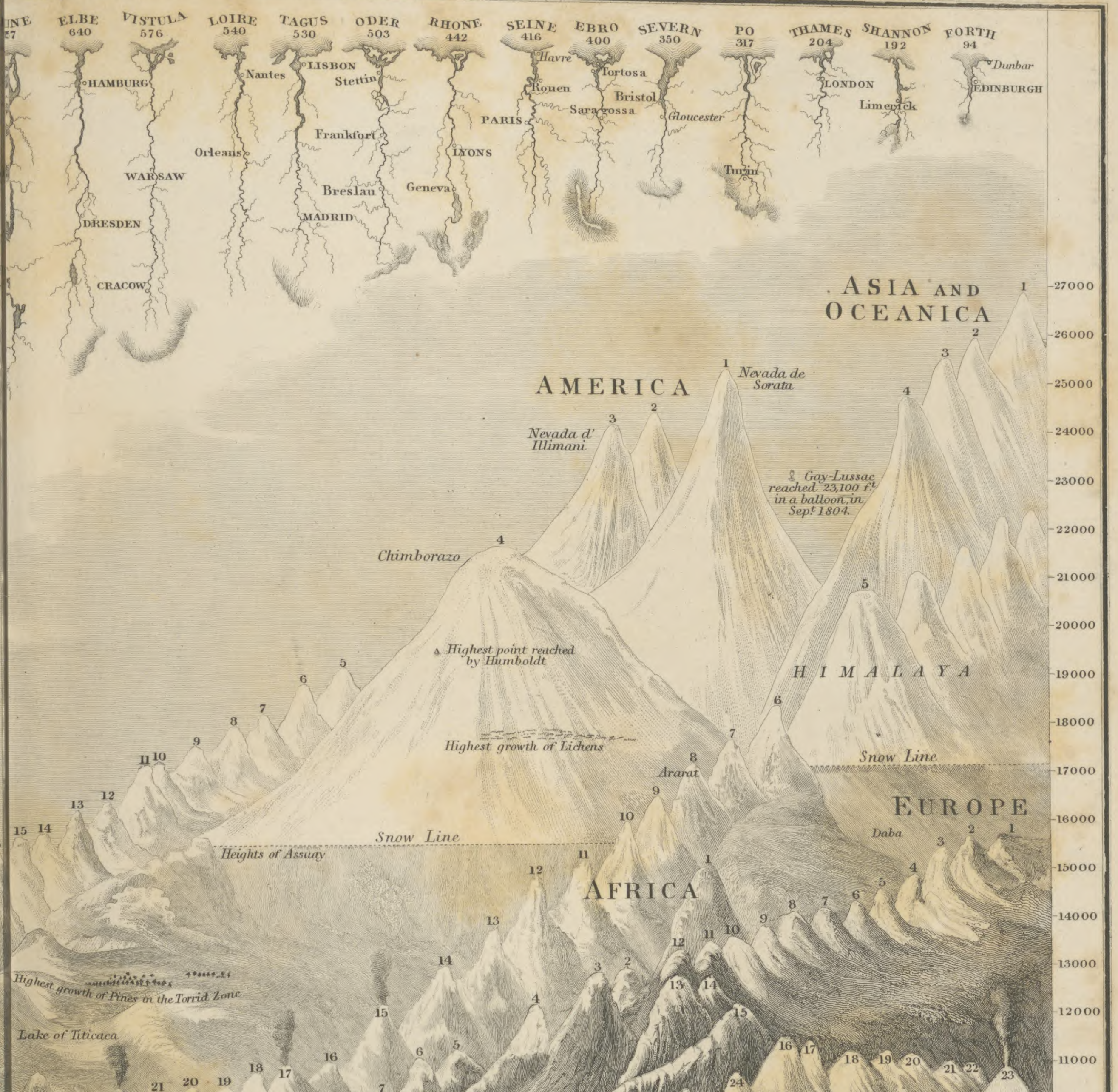
क	ख	ग	घ	ङ	च	छ	ज	झ	ञ	ट	ठ	ड	ढ	ण	त	थ	द
kĕ	khĕ	ga	gha	ń or ñgĕ	chi	chha	ja	jha	ñya	tà	thà	de	dhe	na	tē	t,hē	dĕ

ध	न	प	फ	ब	भ	म	य	र	ल	व	श	ष	स	ह	क्ष	ज्ञ
d,hĕ	ne	pa	p,ha	bĕ	bhe	mĕ	yĕ	rĕ	lĕ	wĕ	să	sha	izh	khà	x	ñya or gya

Geo. Aikman Sculpt.

PHYSICAL GEO



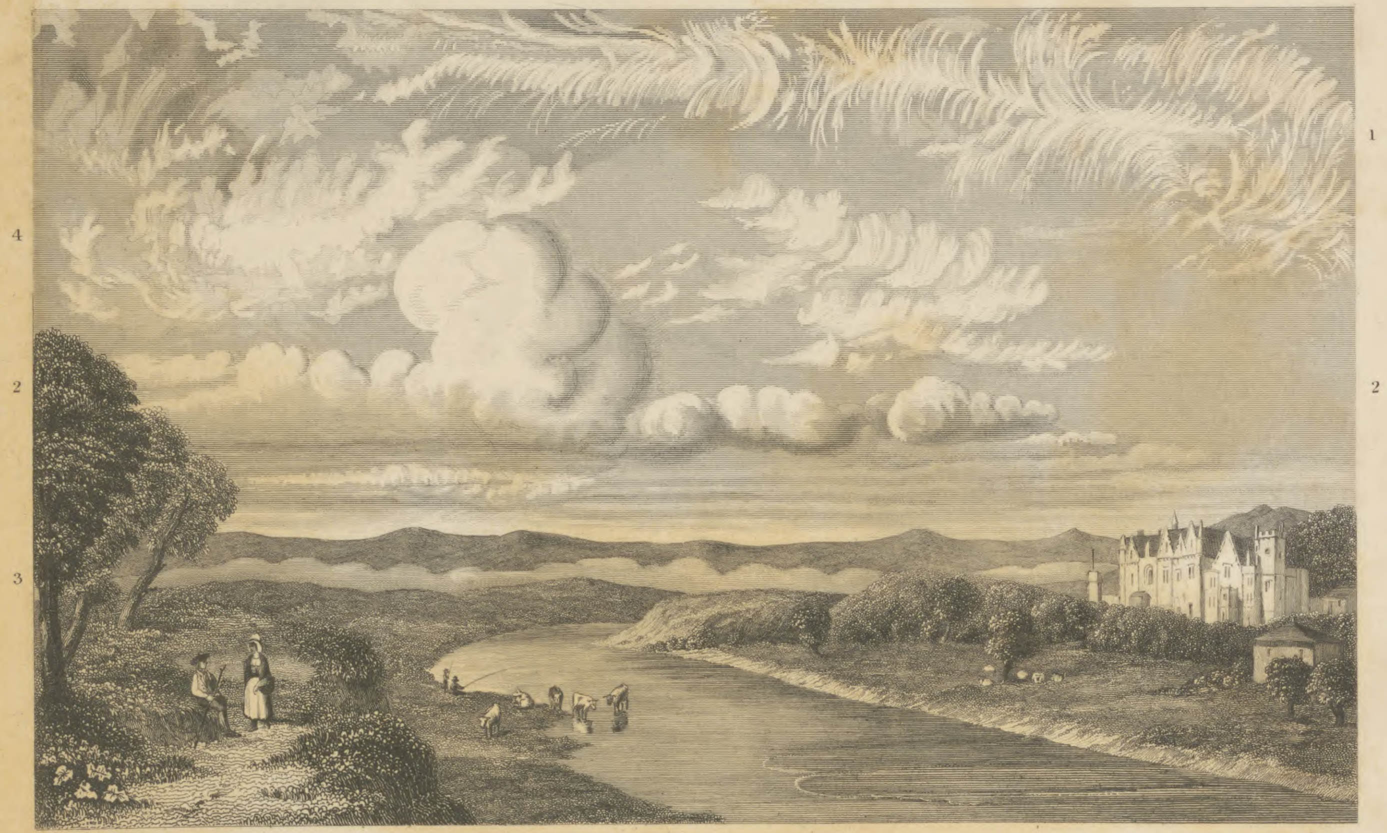


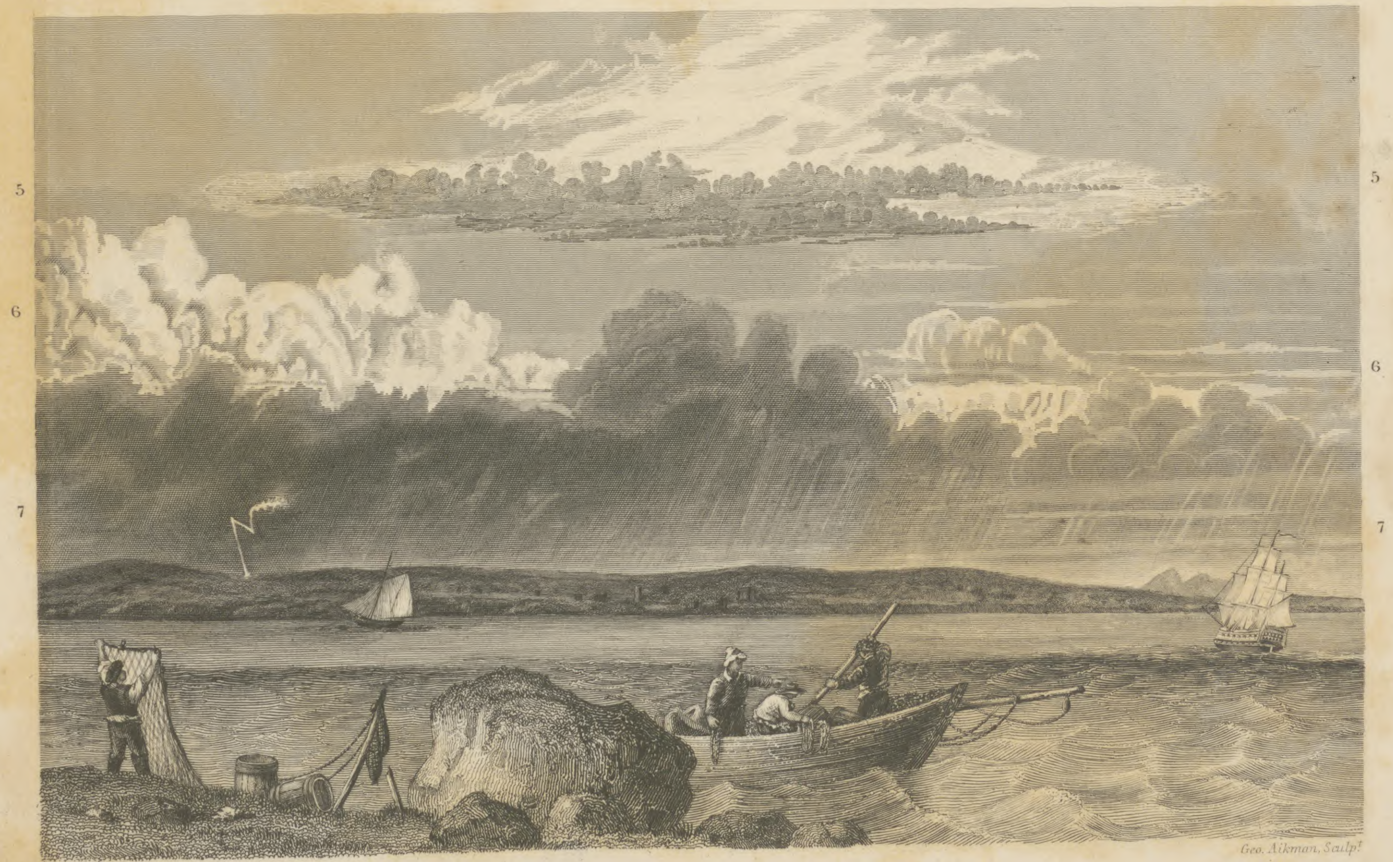
Geo. Aikman Sculpt.

PHYSICAL GEOGRAPHY.

PLATE CCCCXI.

CLOUDS.

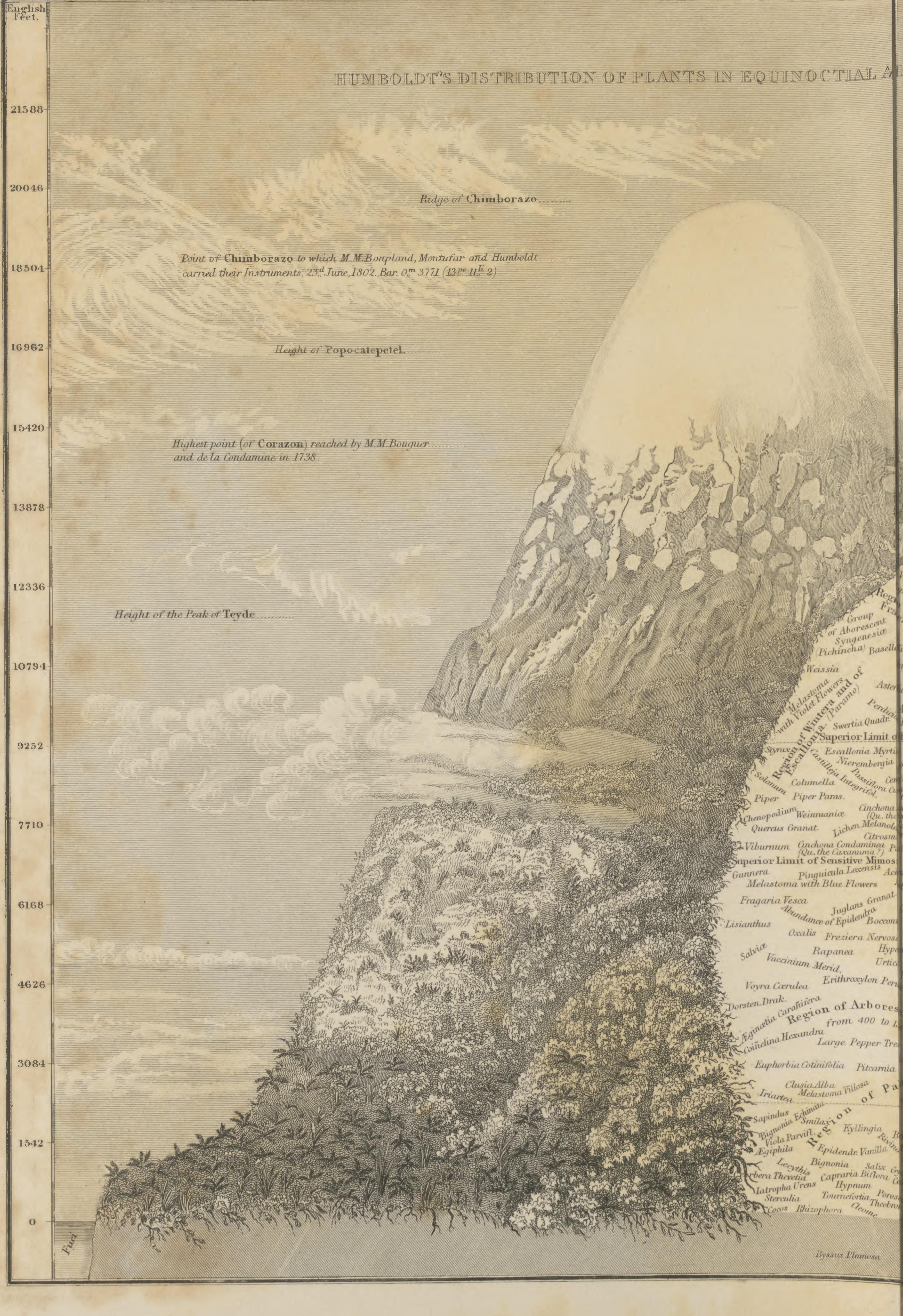




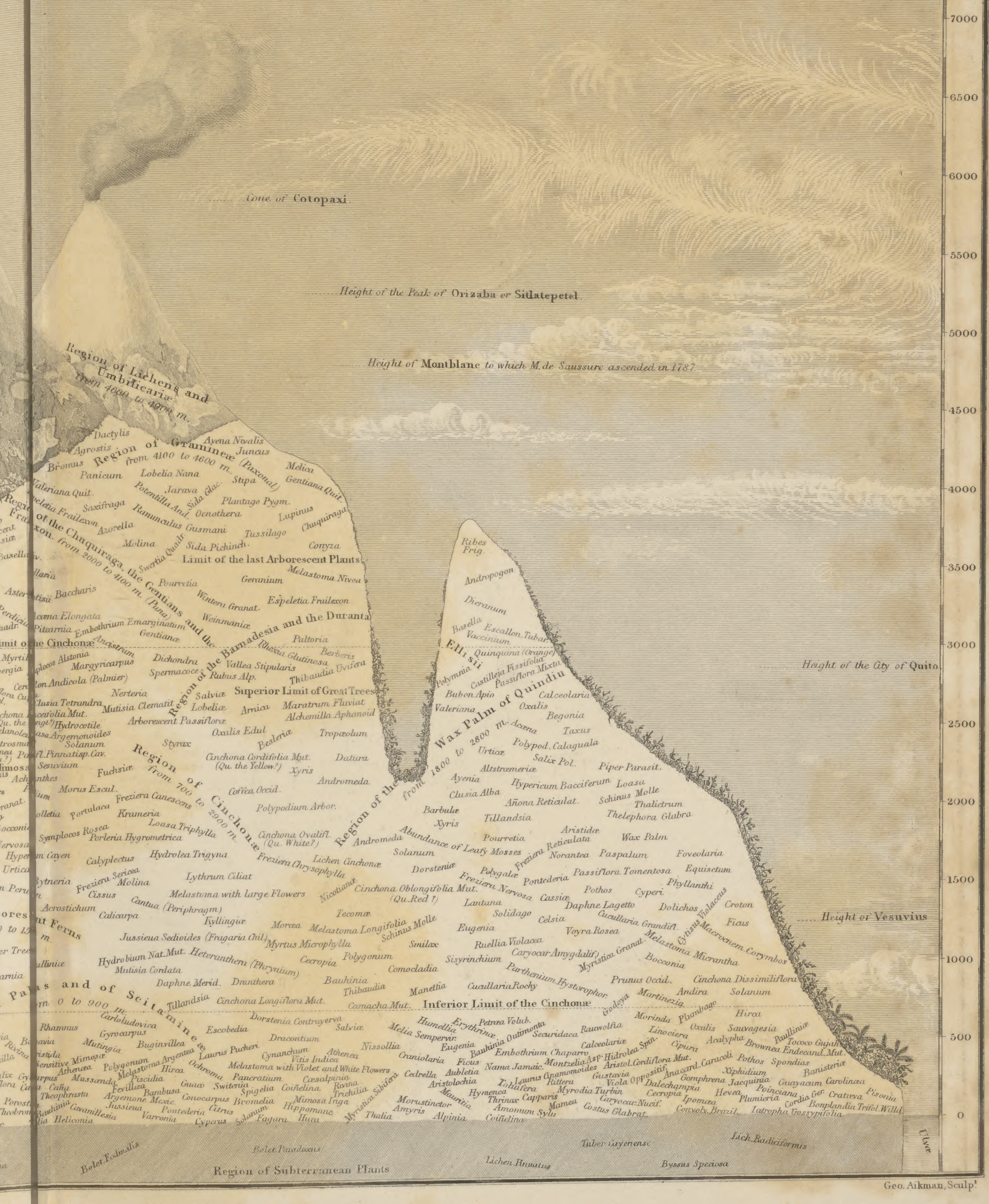
P. A. Delᵗ.

Geo. Aikman, Sculpᵗ.

PHYSICA G


HUMBOLDT'S DISTRIBUTION OF PLANTS IN EQUINOCTIAL A
English Feet.
21588
20046
18504
16962
15420
13878
12336
10794
9252
7710
6168
4626
3084
1542
0
Ridge of Chimborazo
Point of Chimborazo to which M.M. Bonpland, Montufar and Humboldt carried their Instruments. 23rd June, 1802. Bar. 0m 3771 (13Po 11li 2)
Height of Popocatepetel.
Highest point (of Corazon) reached by M.M. Bouguer and de la Condamine in 1738.
Height of the Peak of Teyde
Fuci
Group of Aborescent Syngenesiæ (Pichincha)
Basella
Weissia
Melastoma with Violet Flowers
Region of Wintera and of Escallonia. (Paramo)
Aster
Perdicium
Swertia Quadr.
Superior Limit of the Ci
Styrax
Escallonia Myrti
Nierembergia
Castilleja Integrifol.
Passiflora
Solanum
Columella
Piper
Piper Paras.
Chenopodium
Weinmaniæ
Cinchona
(Qu. the
Quercus Granat.
Lichen Melanole
Citrosm
Viburnum
Cinchona Condaminea (Qu. the Caxanuma?)
Superior Limit of Sensitive Mimos
Gunnera
Pinguicula Loxensis
Melastoma with Blue Flowers
Fragaria Vesca
Juglans Granat.
Abundance of Epidendra
Bocconi
Lisianthus
Oxalis
Freziera Nervosa
Salviæ
Rapanea
Vaccinium Merid.
Urtica
Voyra Cærulea
Erithroxylon Peru
Dorsten. Drak.
Æginætia Carañifera
Region of Arbores
from 400 to 1
Coiñelina Hexandra
Large Pepper Tre
Euphorbia Cotinifolia
Pitcarnia
Clusia Alba
Melastoma Villosa
Iriartea
Region of Pa
Sapindus
Bignonia Echinata
Smilax
Kyllingia
Viola Parvifl.
Ægiphila
Epidendr. Vanilla
Lecythis
Bignonia
Salix
Cerbera Thevetia
Capraria Biflora
Iatropha Urens
Hypnum
Sterculia
Tournefortia
Theobro
Cocos
Rhizophora
Cleome
Byssus Plumosa

L AMERICA, ACCORDING TO ELEVATION ABOVE THE LEVEL OF THE SEA.



Geo. Aikman, Sculpt.

ADVOCATORUM BIBLIOTHECA